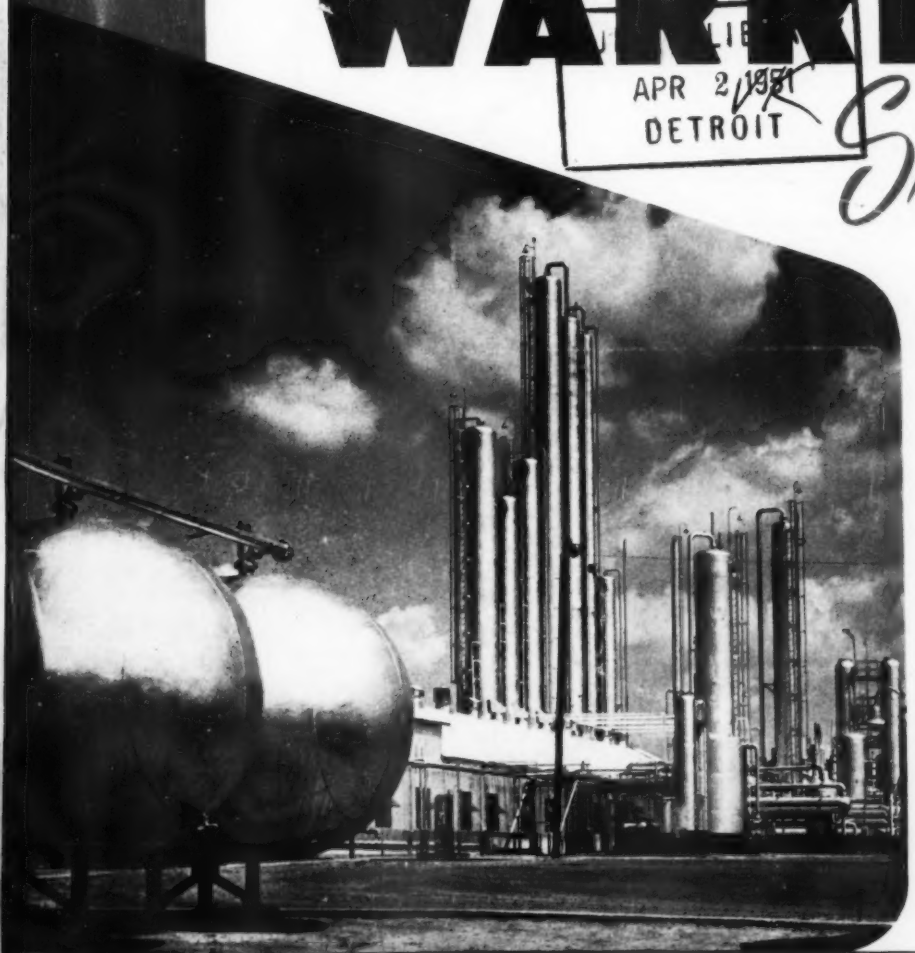
TECHNOLOGY DEPT.

ANNUAL REFINING NUMBER

WITH A SPECIAL REFINING REFRESHER QUIZ!

OIL AND GAS JOURNAL

APR 2 1951
DETROIT



WARREN'S Stabilized NATURAL GASOLINE or STA-VOL-ENE

MEET TODAY'S NEED FOR POWER AND SPEED

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Butane
Propane
Iso-Butane
Iso-Pentane
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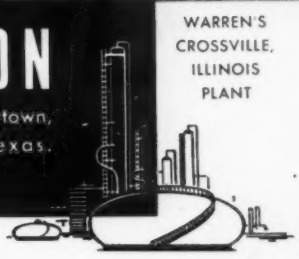

WARREN'S CROSSVILLE, ILLINOIS PLANT

Crude Oil, Natural Gasoline and Liquefied Petroleum Products

PRICE 50 CENTS TABLE OF CONTENTS PAGE 157 **MARCH 29, 1951**

XUM

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Only through intensive research, brutal testing and highly efficient manufacturing facilities can leadership be maintained in the science of cementing. HOWCO'S skilled technicians constantly test, analyze, check and recheck. Their goals are to create, improve and produce more efficient cementing tools ... all of which must surpass the highest standard in the industry. Halliburton's achievements have revolutionized cementing. Remember, *there's no substitute for experience in oil well cementing.* Be sure ... *depend* on Halliburton.

HALLIBURTON OIL WELL CEMENTING CO. DUNCAN OKLAHOMA

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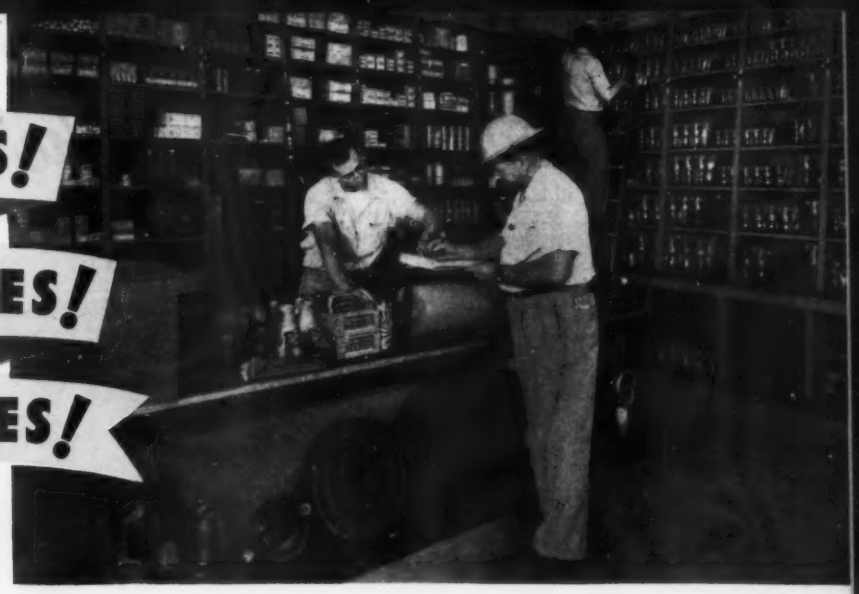
QUANTITY?... YES!

VARIETY?... YES!



TAYLOR FORGE WELDING FITTINGS

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BETHLEHEM STUDS AND NUTS

Refinery Stocks at Bethlehem Stores are BIG...NEW...UP-TO-THE-MINUTE

...amless pipe, tubing; Bethlehem Lap ...Weld and Beth-Co-Weld pipe; Bridgeport ...ass Co. condenser and exchanger tubes.

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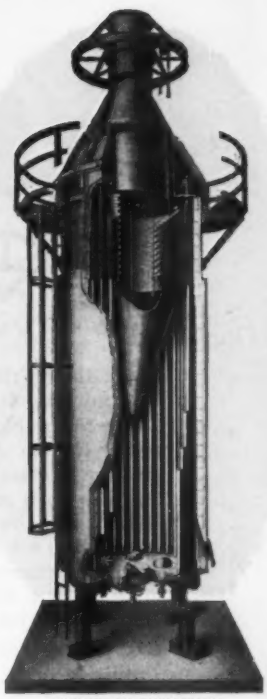
WORTHINGTON PUMPS

When you're after refinery supplies, the best, most convenient place to call is the Bethlehem Supply store. There's one in every refinery area . . . big, neat, stocked to the ceilings with the goods most commonly in demand.

Studs and nuts, pipe and tubing, valves, fittings, hose and packing, tools, instruments . . . these and scores of other items are always available. Engineered products, such as pumps or furnaces, can be secured on short notice; and your job of selection is made easier by the services of Bethlehem's refinery sales personnel.

In refinery matters, let Bethlehem Supply be your "warehouse." It will save you trouble, time, and the cost of writing off obsolescent stocks. Just reach for the telephone — dial the nearest Bethlehem store. We'll do the rest.



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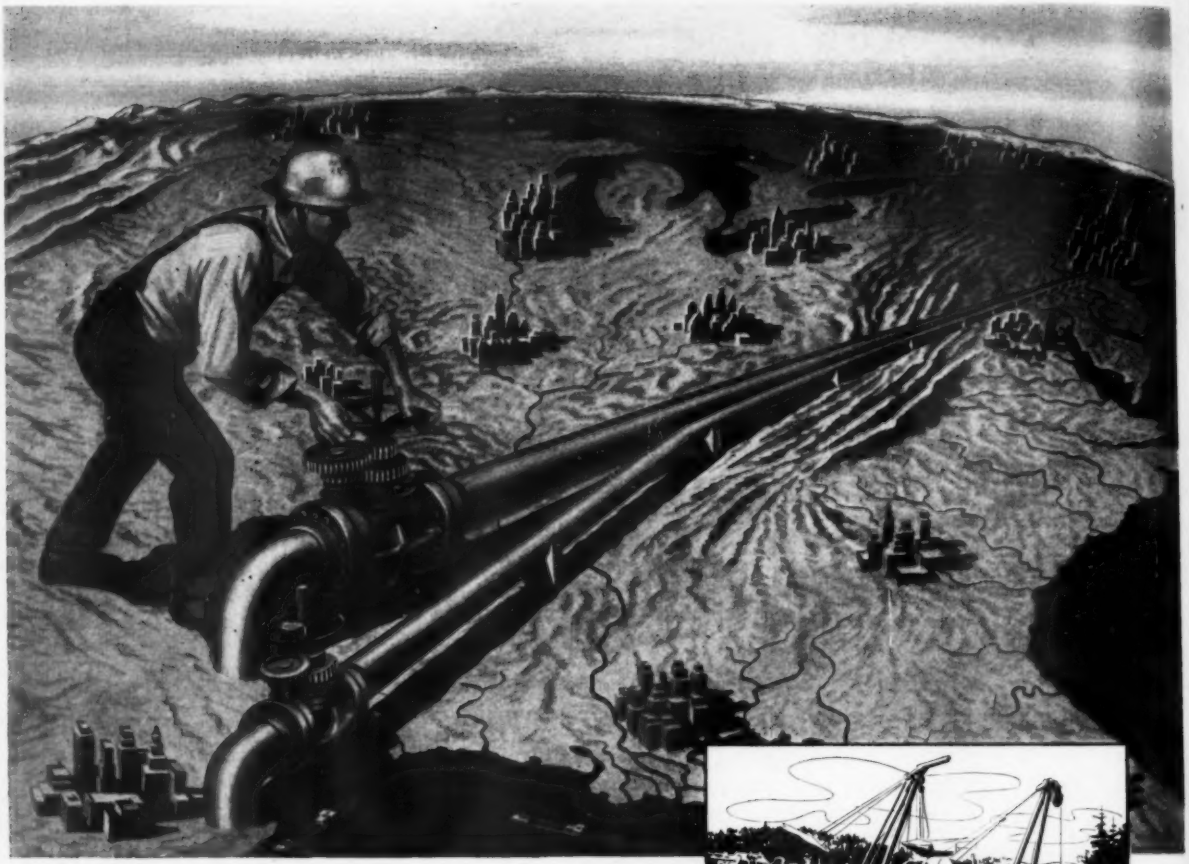
Famous Brands in the Southwest



FLYING WH SPADE DIAMOND H DIAMOND TEXAS EASTERN

Realizing that low-cost transmission of natural gas, from its source on the Gulf Coast to the Northern and Eastern seaboard was vital to America's well-being, Texas Eastern Transmission Corporation purchased the Big Inch and the Little Big Inch Pipe Lines from the Government and converted them from oil and gasoline transmission to gas. The conversion contract was awarded to Brown & Root, Inc., who has done an outstanding job of converting and expanding this vast system.

The Brown & Root staff of specialists makes possible a completely integrated service, including plant location, thorough planning and supervision of construction, and delivery of a ready-to-operate plant, all under one contract . . . one responsibility. If your company's plan calls for new construction or expansion, at your invitation a Brown & Root expert will gladly make a complete survey for you. Why not call or write today; there is, of course, no obligation involved.

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You get MORE CAPACITY with a FANMIX BURNER

Increase Boiler Ratings On Present Or Planned Equipment

In all types of Coppus-Dennis FANMIX Burners — straight gas or combination gas-oil — we utilize the energy of the fuel under pressure to drive the burner fan and deliver air in the proper proportion to the fuel flow. This exclusive "pinwheel action" *mechanically* mixes fuel and air in exactly the right proportions for truly radiant, non-luminous heat.

The result is uniform temperature everywhere in the combustion chamber — no drifting "hot spots" — and complete combustion under all conditions. That's why you can release more heat into your present furnace — why in new installations you get more heat into smaller furnace space.

FANMIX Saves On Both Old and New Installations

FANMIX can easily be operated with your present furnace and stack, requiring only minor changes in other equipment. Or if you're planning on new boilers, remember that FANMIX relieves the furnace from the burden of mixing, creates its own forced draft and takes smaller pipe sizes. Which means you can plan on reduced combustion space, less stack, no forced draft equipment and lower installation costs all around.

Get the Whole Story

Coppus engineers FANMIX Burners to meet individual requirements, providing complete control over heat pattern and combustion . . . Learn more about how "pinwheel action" can step up *your* boiler performance to peak efficiency and economy — as it is doing throughout industry. Send for Bulletin 410-6. Coppus Engineering Corp., Worcester 2, Mass. Sales Offices in THOMAS' REGISTER. Other Coppus "Blue Ribbon" Products in BEST'S SAFETY DIRECTORY, CHEMICAL ENGINEERING CATALOG, REFINERY CATALOG, and MINING CATALOGS.

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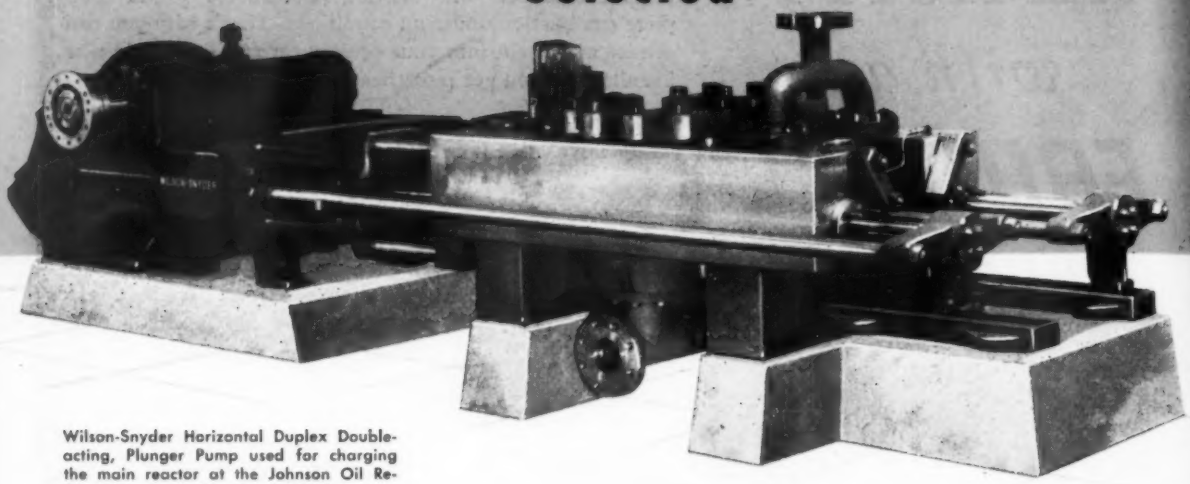
7 out of 13 refiners

...installing UOP's PLATFORMING Process

selected



Wilson-Snyder Horizontal Duplex Double-acting, Plunger Pump used for charging the main reactor at the Johnson Oil Refining Company, Cleveland, Oklahoma.

WILSON-SNYDER PUMPS

In just ONE YEAR . . . the PLATFORMING Process, discovered and developed by Universal Oil Products Company, has proved its merits, and THIRTEEN REFINERS desirous of improving the octane characteristics of straight run and natural gasolines, and producing light aromatic hydro-carbons, have contracted for platforming installations.

A Wilson-Snyder horizontal duplex outside end-packed double-acting plunger-type pump was selected for charging the main reactor in the initial commercial installation of this process at Old Dutch Refining Company, Muskegon, Michigan.

And because of its dependable performance, seven of these thirteen refiners, to date, have specified the proper Wilson-Snyder Pumps for their respective platforming installations.

We're proud of the fact that Wilson-Snyder Pumps are being selected for so many of these installations . . . and invite your Refinery-Pump inquiries. Your local "Oilwell" Representative will expedite the preparation of detailed recommendations to meet your requirements.

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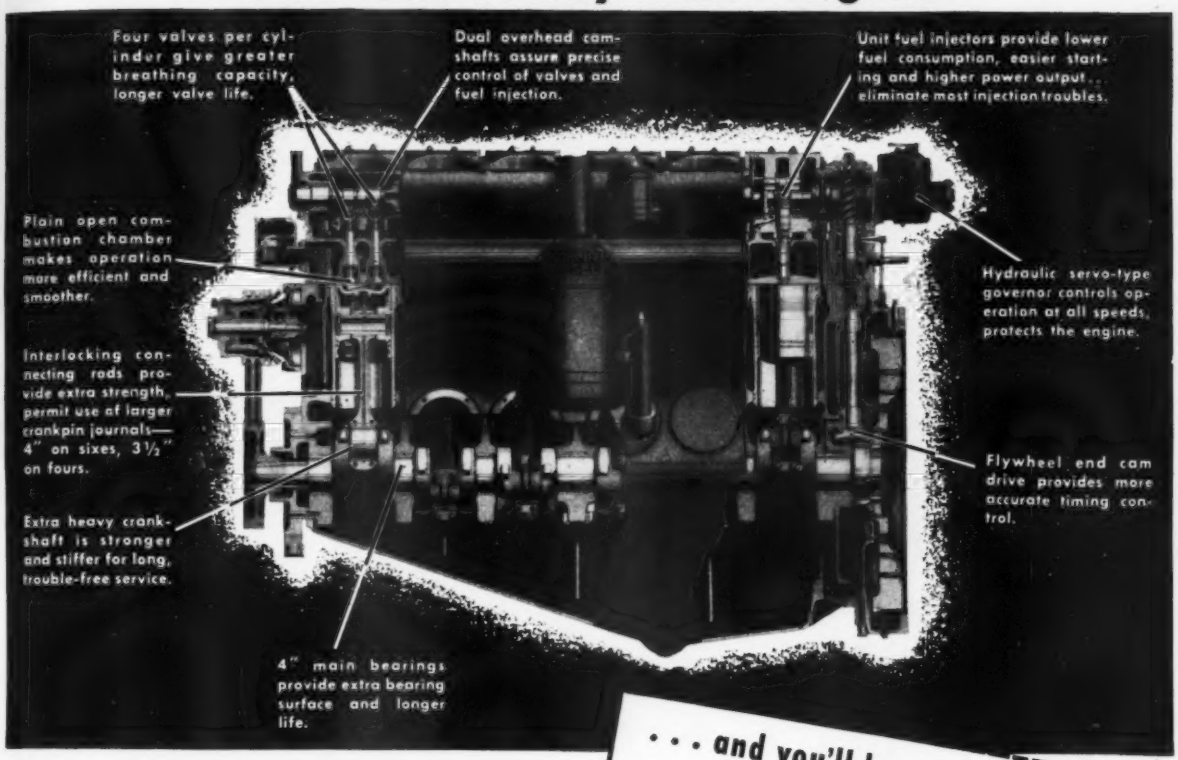
with that of any other engine


Four valves per cylinder give greater breathing capacity, longer valve life.
Dual overhead camshafts assure precise control of valves and fuel injection.
Unit fuel injectors provide lower fuel consumption, easier starting and higher power output... eliminate most injection troubles.
Plain open combustion chamber makes operation more efficient and smoother.
Hydraulic servo-type governor controls operation at all speeds, protects the engine.
Interlocking connecting rods provide extra strength, permit use of larger crankpin journals— 4" on sixes, 3½" on fours.
Flywheel end cam drive provides more accurate timing control.
Extra heavy crankshaft is stronger and stiffer for long, trouble-free service.
4" main bearings provide extra bearing surface and longer life.

. . . and you'll know why it gives you

- **MORE POWER**
- **GREATER ECONOMY**
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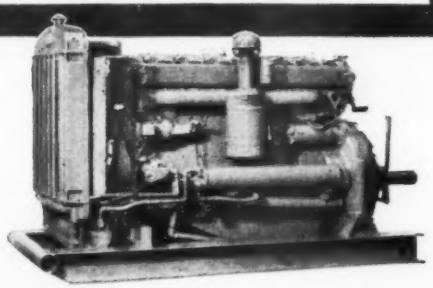
MURPHY DIESEL

Heavy duty power

for the oilfields

Murphy Diesel Engines and Power Units for drilling and pipe line pumping, 90 to 226 H.P., 1200 and 1400 RPM. Generator Sets, 60 to 140 K.W. Dual-Fuel Engines, 135 to 180 H.P. Also Crude Oil Burning Engines.



ONLY with Murphy Diesel do you get all the advanced design features described above . . . and only with Murphy Diesel do you get all extra power, economy, dependability and engine life that this design assures. Proved in thousands of hours of the toughest kind of service, this design has resulted from skilled engineering and long practical experience.

A more detailed discussion of these features and others is given in the booklet, *"10 Questions to Ask a Diesel Engine Salesman."* You can get a copy from your Murphy Diesel Dealer or we'll be happy to send you one.

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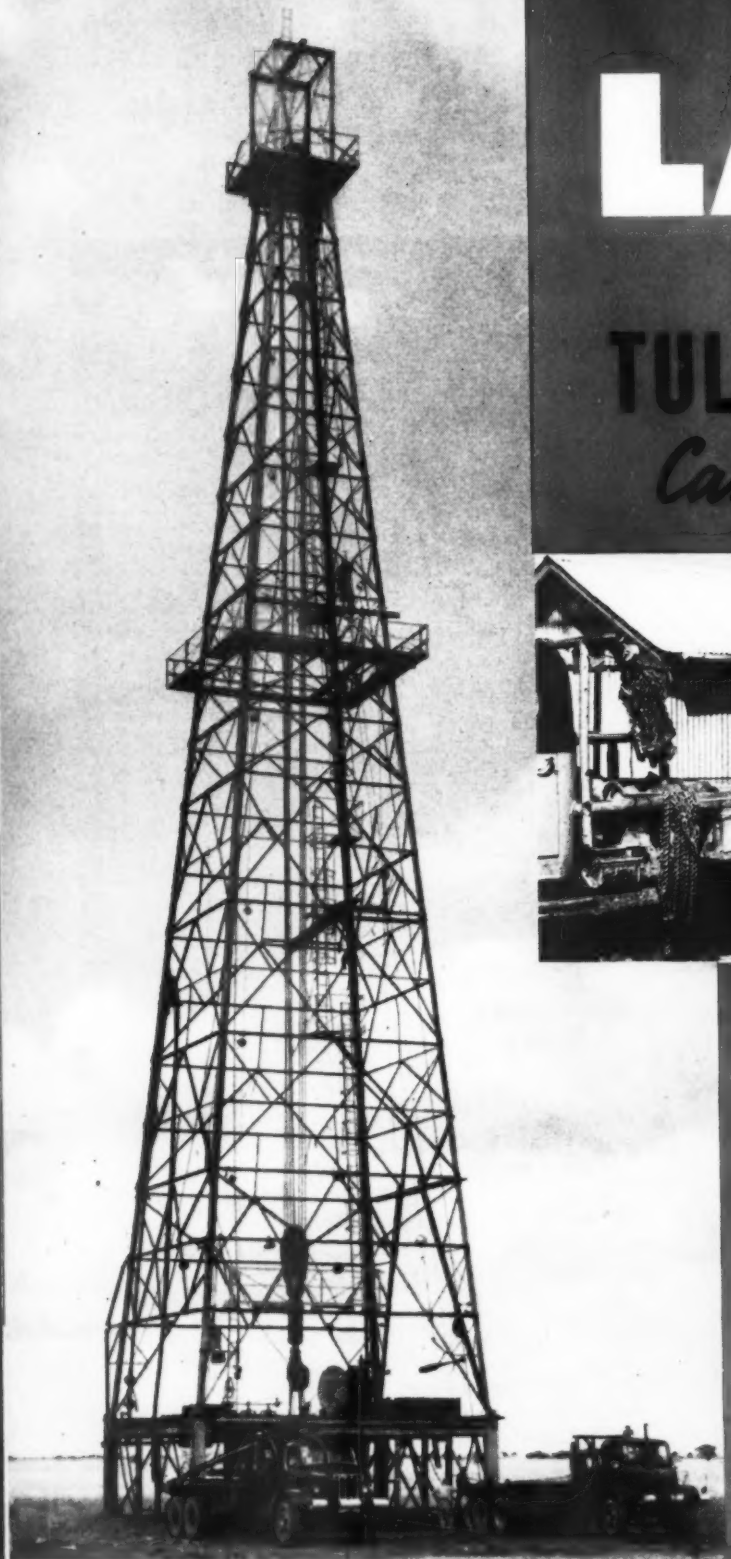
LARGE

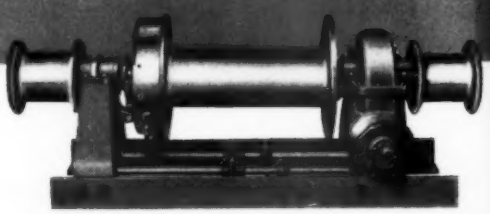
or SMALL

TULSA* WINCHES

Can do them all



No matter what your winching requirement may be, there's a Tulsa* Winch designed to do the job. Tulsa Winches are available in 28 models, ranging in capacities from 6,000 to 80,000 pounds. Each component part is engineer-designed and manufactured with the utmost precision. There is a Tulsa Winch for every model and make of trucks and all models of crawler tractors. Contact your nearest Tulsa Winch distributor or write direct to Tulsa Winch.



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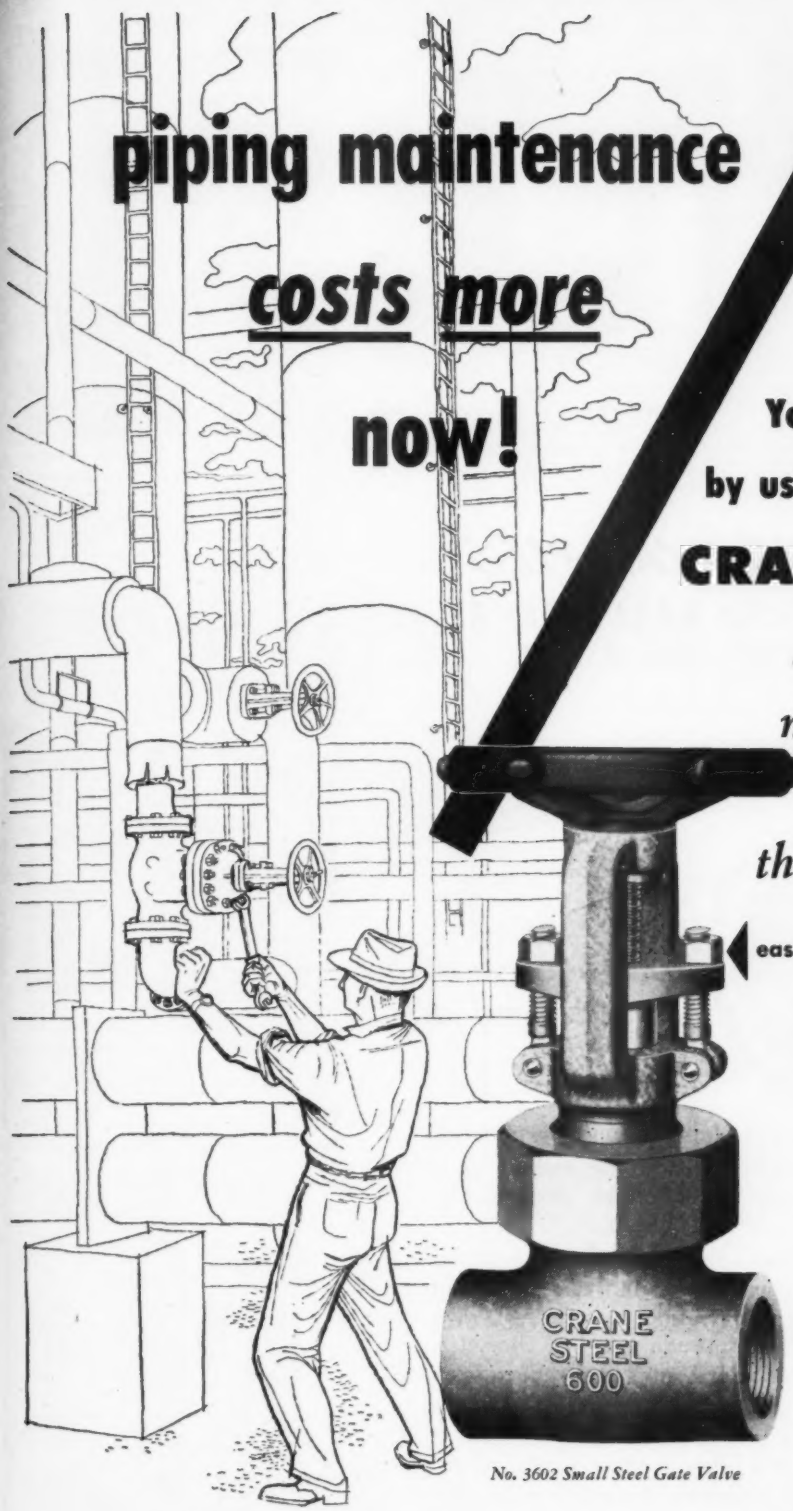
piping maintenance costs more now!

You do less of it by using Dependable Quality

CRANE VALVES

...That's why more Crane Valves are used than any other make



No. 3602 Small Steel Gate Valve

easy to use...easy to keep on the job

You'll have much less valve maintenance wherever you install Crane 600-Pound Small Steel Gates. Use with recommended trim on oil or oil vapor, steam, water, air, or gas.

Compact yet rugged—light yet strong—these are truly small steel valves with big valve features. They sacrifice nothing that insures dependability and tight seating, easy operation, and convenience in keeping them in top-notch working condition.

Supplied in sizes 2 inches and smaller, No. 3602 valves are engineered to the standards that make Crane Quality your best choice in valves of every type.

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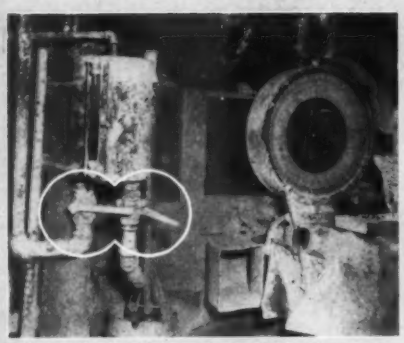
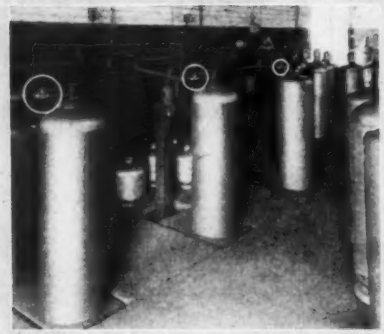
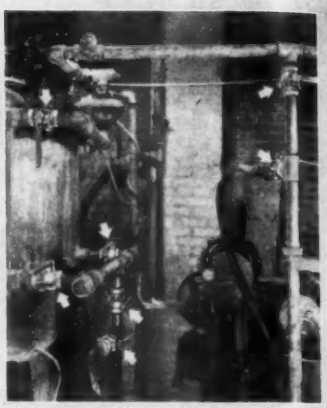


LIBBEY-OWENS-FORD GLASS COMPANY — Two 1½" Rockwood Ball Valves operated 350,000 times with no maintenance. Used on river water to mix plaster for the grinding and polishing line. Valves are operated 1500 times a day. Only valve to stay in service over a year.



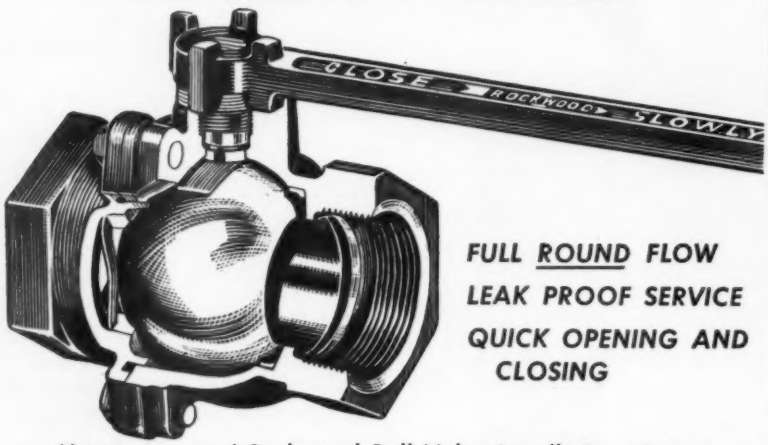
LARGE PROPANE PLANT — Rockwood Ball Valves have increased production by cutting down time and labor. Each valve is opened and closed every two minutes and between 300 and 400 tanks are shipped out daily. No maintenance.



IROQUOIS CHINA COMPANY, SOLVAY, NEW YORK — Foreman says "Rockwood Ball Valves are operated 40 times a day handling a mixture of clay and water. Each valve has performed better, operated easier and lasted longer than any other valve we ever used."

5 OUTSTANDING EXAMPLES—

PROVE ROCKWOOD BALL VALVES "OUT-PERFORM" THEM ALL



FULL ROUND FLOW

LEAK PROOF SERVICE

QUICK OPENING AND CLOSING

Here are actual Rockwood Ball Valve installation pictures.

Rockwood Ball Valves have already made, in various types of industries, an outstanding record for longer, dependable, efficient performance.

Three chief reasons for the amazing Rockwood Valve record is the leak proof service, full round flow, and quick opening and closing. These remarkable engineering features will give efficient and economical operation through years of everyday use. Together, they help increase your profits and reduce your maintenance cost.

Rockwood Ball Valves are giving outstanding service in chemical, food, paper, textile and other process plants, oil refineries and many other types of industries. Available in all pipe sizes from ½" to 4", for 300 p.s.i. working pressure.

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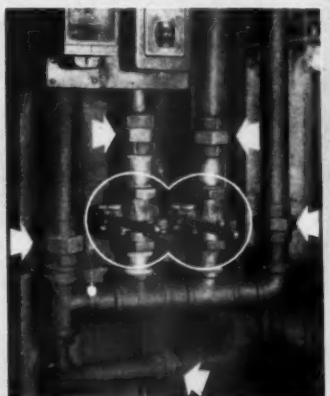
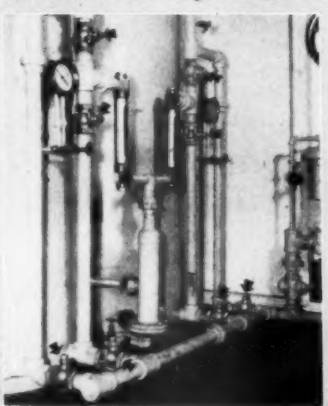


REVERE COPPER and BRASS INCORPORATED — Rockwood Ball Valves on quenching lines for annealing furnaces are operated 60 times a day under 100 p.s.i. Unfiltered river water flows thru the valves. Both valves have lasted 4 times longer than any other make of valves. Note Rockwood cold forged steel unions.



GASOLINE LINES ON "SWEETENING TOWERS" — Maintenance Engineer of this large gas company says, "The full round flow, leak proof service, easy operation and no maintenance cost make Rockwood Valves far ahead of any competitive valve we have used."

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NOW AND IN THE RECENT PAST
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FOR 1952
WE ARE THE ORIGINATORS OF THE "NEW LOOK" IN REFINERIES, WITH "PICTURE WINDOWS" TO MAKE THE PUBLIC CONSCIOUS OF YOUR PROGRESSIVENESS.

You remember how fast 1950 passed. 1951 will seem to pass even more quickly and by 1952 you will wish your refinery were modernized or that you had an entirely new plant.

You can have that new cat cracker or new refinery if you plan now, and place your problem in our hands. We have the ability, manpower and equipment to design, engineer and construct the refining facilities you need in the least possible time.

Call, wire or write for a discussion of your refining problems and their solution, without obligation. Our airplanes make us neighbors.

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cut threads

BETTER FASTER CHEAPER

1. LANDIS DIE HEADS cut tool cost by using chasers that are independent units. Worn or damaged chasers are reground or replaced *individually*, without affecting the remaining chasers of the set.

2. LANDIS DIE HEADS reduce tool inventories by cutting *both* right- and left-hand threads with a *single* set of chasers. Chasers are ground on both ends, the spring action in the die head is reversed, and either a right-hand or left-hand set of chaser holders is used.

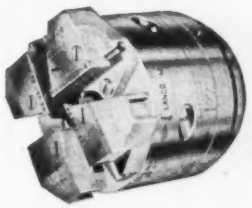
3. LANDIS DIE HEADS cut all diameter threads with a constant pitch and form within the rated range of the die head with a *single* set of chasers. Short thread lengths larger than the rated diametrical range can be cut with the *same* die head equipped with over-size chaser holders.

4. LANDIS DIE HEADS use chasers that can be reground for most of their original length. Regrinding is a simple operation restoring the entire cutting edge and leading feature, yet retaining the initial accuracy of pitch, diameter, and depth of cut.

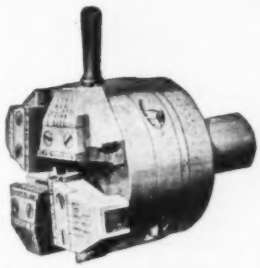
5. LANDIS DIE HEADS improve thread finish and cut production costs by reducing chaser wear and breakage. The tangential position of the chaser to the work allows lateral absorption of cutting strains. Resulting reduced friction and vibration make higher cutting speeds possible without causing thread distortion or chaser breakage.

6. LANDIS DIE HEADS consistently produce threads accurate for lead. Regrinding does not destroy the lead controlling feature of the chasers. Thus this feature assures accurate pitch threads throughout the chaser's life.

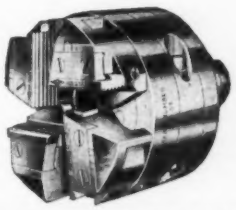
7. LANDIS DIE HEADS are built to stay on the production line. Tough, high-carbon steel is used in all parts. Rigid construction maintains accuracy, and minimizes wear of working parts. Landis Die Heads are furnished in two models, heat-treated or hardened-and-ground, depending on the application and quality of thread desired.



LANCO—a revolving die head for hand-operated, semi-automatic, and automatic threading machines.



LANDMATIC—a stationary die head with self-opening action for turret lathes.



LANDEX—a revolving die head for automatic screw machines and other "live spindle" machines.

LANDIS *Machine* COMPANY

WAYNESBORO · PENNA.

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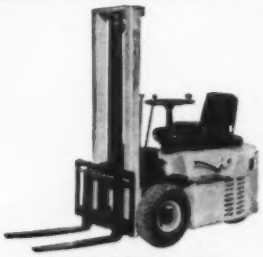
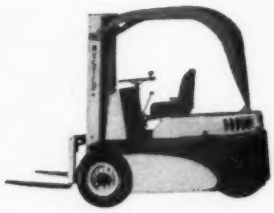
Pioneer Manufacturers of a Complete Line of Industrial Trucks

Lift Trucks for the Petroleum Industry



HYSTER 20

Capacity — 2000 pounds
Width — 37 inches
Length — 71 inches (less forks)

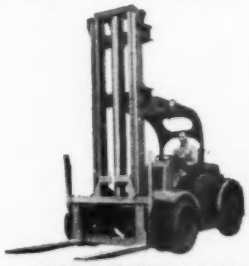


HYSTER 40

Capacity — 4000 pounds
Width — 42 inches
Length — 86 inches (less forks)

HYSTER 75

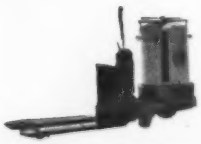
Capacity — 7500 pounds
Width — 60 inches
Length — 117½ inches (less forks)



HYSTER 150

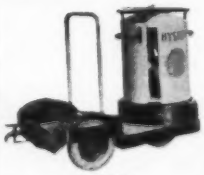
Capacity — 15,000 pounds
Width — 86 inches
Length — 148 inches (less forks)

HYSTER *Salsbury* TURRET TRUCKS



PALLET TRUCK

Capacity — 4000 pounds
Width — 35 inches
Length — 86 in. and 110 in.

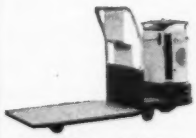


TUG

Towing cap. — 20,000 lbs.
Width — 42 inches
Length — 62 inches

PLATFORM TRUCK

Capacity — 4000 pounds
Width — 35 inches
Length — 97 in. and 115 in.



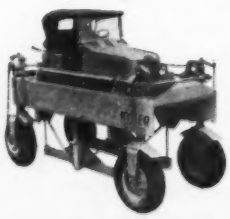
CARGO TRUCK

Capacity — 4000 pounds
Width — 42 inches
Length — 103½ inches

AUTO-LOADER

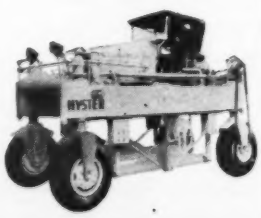
Towing cap. — 20,000 lbs.
Width — 20 inches
Length — 135 inches

Straddle Trucks



M STRADDLE TRUCK

Capacity — 18,000 lbs.
Width — 78½ in. and 90½ in.
Length — 176 inches



MH STRADDLE TRUCK

Capacity — 30,000 pounds
Width — 90 in. and 100 in.
Length — 190½ inches

MOBILE CRANE

HYSTER KARRY KRANE

Capacity — 10,000 pounds
Width — 75 inches
Length — 152 inches

DAVISON

M-S* MICROSPHEROIDAL CATALYST

DA-1* GROUND CATALYST

SUPERIOR PERFORMANCE THROUGH UNIFORM QUALITY

Uniformity in physical characteristics and chemical purity increases operation efficiency of synthetic fluid-type cracking catalysts. Rigid production controls . . . years of experience as a leading producer of catalysts insures the uniformity of Davison Catalysts. Your requirements can now be supplied in either microspheroidal (M-S*) or ground (DA-1*) form... both available in various average particle sizes. Davison also offers development and production of catalysts to meet specific processes.

*T.M.T.D.C.C.

Progress through Chemistry

THE DAVISON CHEMICAL CORPORATION

Baltimore 3, Maryland

PRODUCERS OF: CATALYSTS, INORGANIC ACIDS, PHOSPHATES, PHOSPHATE ROCK, SILICA GELS, SILICOFLUORIDES AND FERTILIZERS

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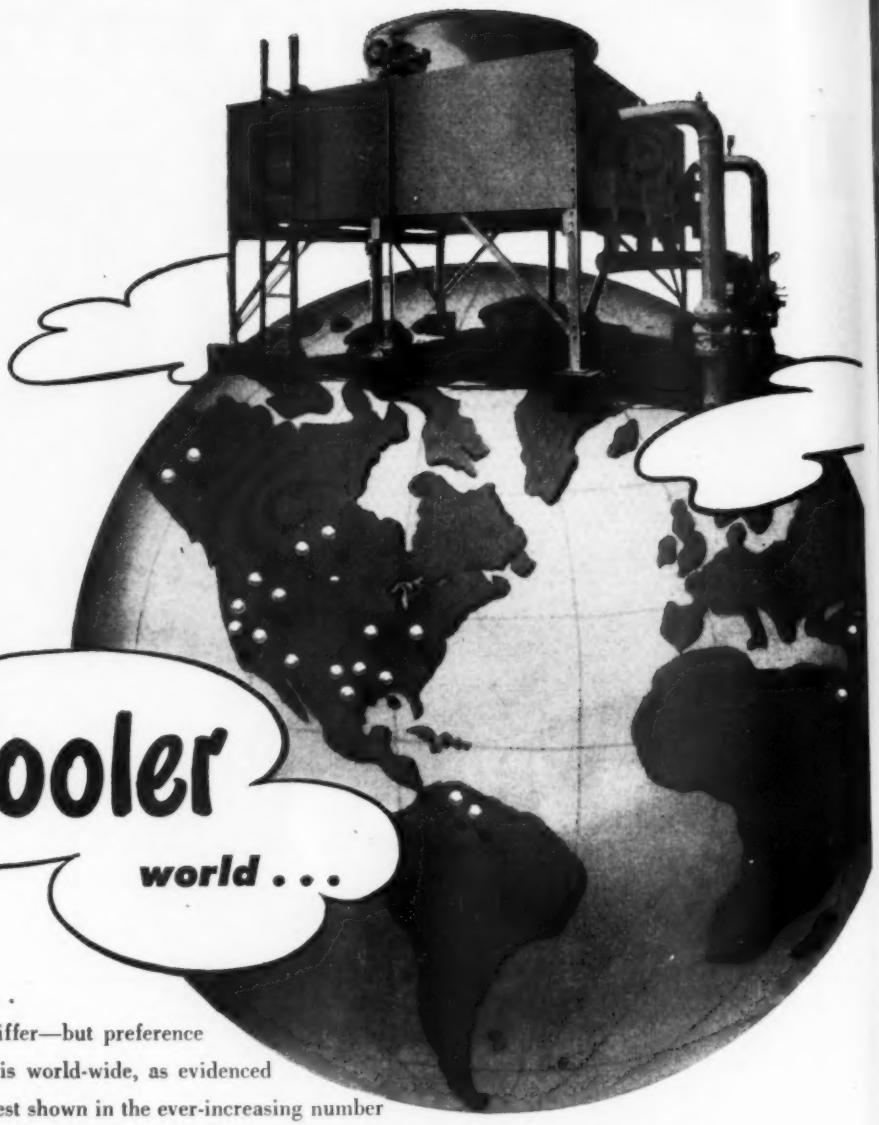
from Arizona to Arabia



it's a* DriCooler *world . . .

Climates vary . . . cooling requirements differ—but preference for Marley DriCoolers is world-wide, as evidenced by the exceptional interest shown in the ever-increasing number of DriCooler installations throughout the world. Consider all factors — weather conditions, fluid to be cooled, horsepower required, influence of corrosion, and many more — and you'll find that Marley offers you the best, most economical dry cooler for your specific job.

This is so because Marley makes a *complete* line of DriCoolers in a wide range of capacities and designs; because each Marley DriCooler is *engineered for the job*, whether it be to cool jacket water in the Arctic or lube oils in the burning desert.

There's a Marley application engineer in every major city, whose services and experience are yours for the asking. Call your Marley man for full details or write for Bulletin DC-50.

Also producers of
AQUATOWERS
VAIRFLO TOWERS
DOUBLE-FLOW TOWERS
NATURAL DRAFT TOWERS
SPRAY NOZZLES

MARLEY

The Marley Company, Inc.
KANSAS CITY 15, KANSAS

OLD . . . Bitumastic Enamel being applied by the "Sling Method."

NEW . . . Bitumastic Enamel being machine-applied.

PIPE-LINE PROTECTION

IS *better than ever* WITH BITUMASTIC!

● BITUMASTIC has a remarkable history of corrosion-prevention, dating back nearly 100 years. And 50 years ago, Bitumastic Enamel "came into its own" for pipe-line protection.

But years ago it wasn't easy to apply protective coatings. For example, the "Sling Method" shown in the photograph on the left was used by many pipeliners. One man poured the hot enamel into the sling; two men "see-sawed" the sling up and down. Naturally this manual method was slow and laborious.

It's a different story today. Pipe lines are cleaned, primed, coated and wrapped mechanically. The coating machine, shown in the photograph on the right, applies Bitumastic quickly and evenly. Bitumastic is a better product, too. Improved formulation makes it easier to handle and apply.

Today, thousands of miles of the world's oil and gas pipe lines are effectively protected against corrosion by Bitumastic Enamel. Get the *same* effective protection by specifying Koppers Bitumastic Enamel for your next pipe-line project.

Why Bitumastic Enamels give lasting protection

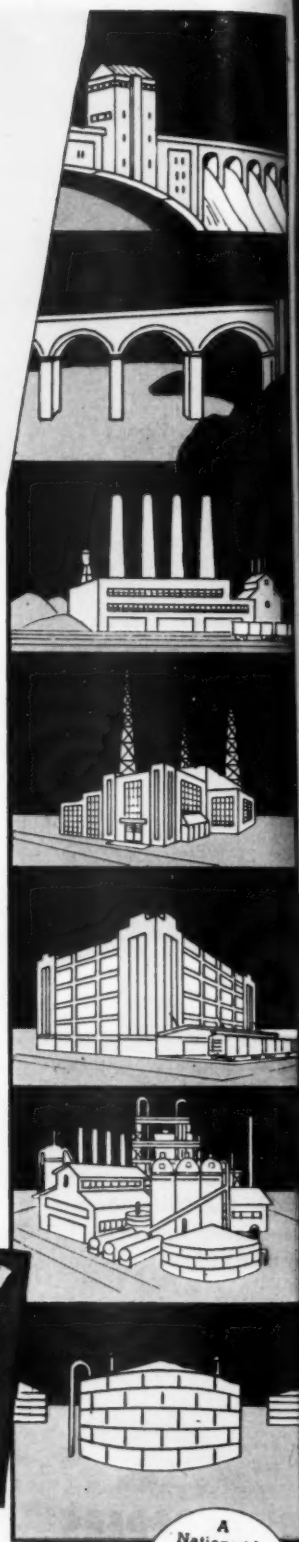
Processed from a base of coal-tar pitch, they are impervious to moisture . . . chemically resistant to soil elements. They make a tight bond with the pipe . . . do not disintegrate with age . . . maintain continuously high electrical resistance.

KOPPERS BITUMASTIC ENAMELS

REG. U.S. PAT. OFF.

KOPPERS COMPANY, INC., Tar Products Division, Dept. 303T, Pittsburgh 19, Pa.

Light! ... for PROTECTION



Type DCX-18 Searchlight

America is faced with the ever-present danger of sabotage that would cripple vital services and production facilities. Sabotage thrives in darkness. The most reliable and cheapest form of protection against night prowlers is LIGHT!

CROUSE-HINDS Floodlights

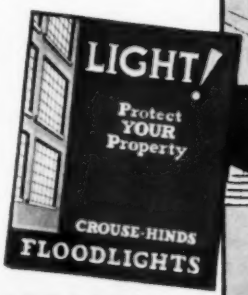
project powerful beams of light that bathe all approaches to your property with glaring radiance, killing darkness and shadows and compelling everyone to be more visible at night than in broad daylight.

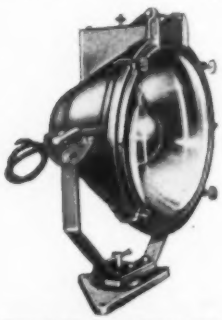
The protective power of light should be used in all important municipal and industrial locations, including waterworks, dams, pumping stations, gas works and gas storage tanks, electric power plants and substations, factories, mills, mines, bridges, docks, warehouses, railway terminals, tunnels, shops and freight houses, canal locks, and aqueducts, oil refineries, pump houses and storage tanks, telephone and telegraph stations, radio stations.

The floodlighting of industrial plants serves a double purpose. It helps to boost production in addition to the security it provides.

Type ADE-14 Floodlight

Crouse-Hinds offers a complete line of floodlights and searchlights that will meet the needs of any type of protective lighting. Crouse-Hinds illumination engineers have a wealth of protective lighting knowledge that is at your service. Send for your copy of Bulletin 2565, "LIGHT! Protect Your Property."





Type LCE-1120 Floodlight

CROUSE-HINDS COMPANY
Syracuse 1, N. Y.

Offices Birmingham — Boston — Buffalo — Chicago — Cincinnati — Cleveland — Dallas Denver — Detroit — Houston — Indianapolis — Kansas City — Los Angeles — Milwaukee Minneapolis — New York — Philadelphia — Pittsburgh — Portland, Ore — Salt Lake City San Francisco — Seattle — St. Louis — Washington. *Resident Representatives.* Albany Atlanta — Baltimore — Charlotte — New Orleans — Richmond, Va
CROUSE-HINDS COMPANY OF CANADA, LTD., TORONTO, ONT.

A Nationwide Distribution Through Electrical Wholesalers

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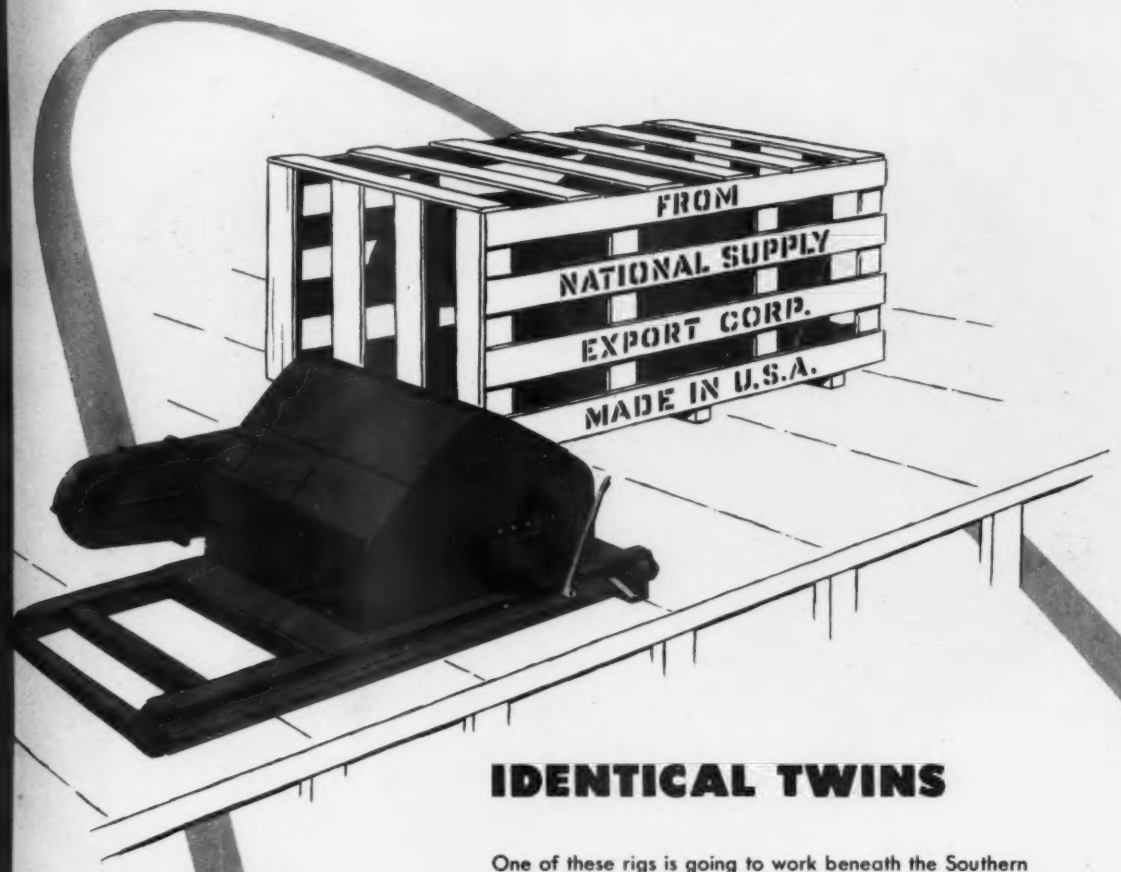

IDENTICAL TWINS

One of these rigs is going to work beneath the Southern Cross . . . the other one in a field of bluebonnets. Yet they could change locations without changing a bolt.

"National Blue" equipment is built to a single standard . . . a standard that carries through every line of products . . . that lets you replace parts confidently and precisely whether you're in Kuwait or Kilgore.

That single standard of quality is coupled with our policy of rating our machinery on the conservative side . . . a combination which means extra service life at lower maintenance cost.

And back of "National Blue" equipment . . . National and "Ideal" machinery, Superior engines, Spang tubular products . . . are scores of National Supply stores across the oil fields of this country and Canada, staffed with expert store crews and servicemen.

Building a top quality line of equipment that's proved by field use and improved by constant development is a major function of The National Supply Company . . . world's largest manufacturer and distributor of a complete, integrated line of oil-country equipment.

THE NATIONAL SUPPLY COMPANY

GENERAL SALES OFFICES: TOLEDO, OHIO

NATIONAL BLUE PRODUCTS

Superior PTD-8 Diesel Drilling Engine

4-cycle means
Economy
Efficiency
Reliability

Superior 6G-510 Gas Drilling Engine

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DESIGNED FOR DOLLAR-WISE DEPENDABILITY

Watch the savings roll up when you put a Superior Engine on your drilling payroll. These dependable 4-cycle engines are famous in every oil field for their long running schedules with low fuel bills and minimum maintenance costs.

The proven 4-cycle principle plus conservative horsepower ratings enable Superior engines to get the most out of every drop of fuel . . . whether you use gas, oil, or a dual-fuel combination.

Continent-wide service and parts facilities give your Superior engine maximum availability, reduce down-time to a minimum.

Pick your Superior from a wide range of naturally-aspirated or supercharged engines that operate on gas, oil, or dual-fuel. Horsepowers range from 280 to 670. Tell us your service and horsepower requirements . . . we'll send bulletins promptly.

THE NATIONAL SUPPLY COMPANY

GENERAL SALES OFFICES: TOLEDO, OHIO

NATIONAL BLUE PRODUCTS

DIVISION OFFICES: CASPER; FT. WORTH; PITTSBURGH; TULSA; TORRANCE.

CANADA: THE NATIONAL SUPPLY COMPANY, LIMITED, ROOM 202, ALBERTA BLOCK, CALGARY, ALBERTA.

EXPORT: NATIONAL SUPPLY EXPORT CORPORATION, 30 ROCKEFELLER PLAZA, NEW YORK, N. Y., U. S. A. RIVER PLATE HOUSE, 12 SOUTH PLACE, LONDON, E. C. 2.

NATIONAL OIL FIELD MACHINERY AND EQUIPMENT . . . SPANG PIPE . . . SUPERIOR & ATLAS ENGINES

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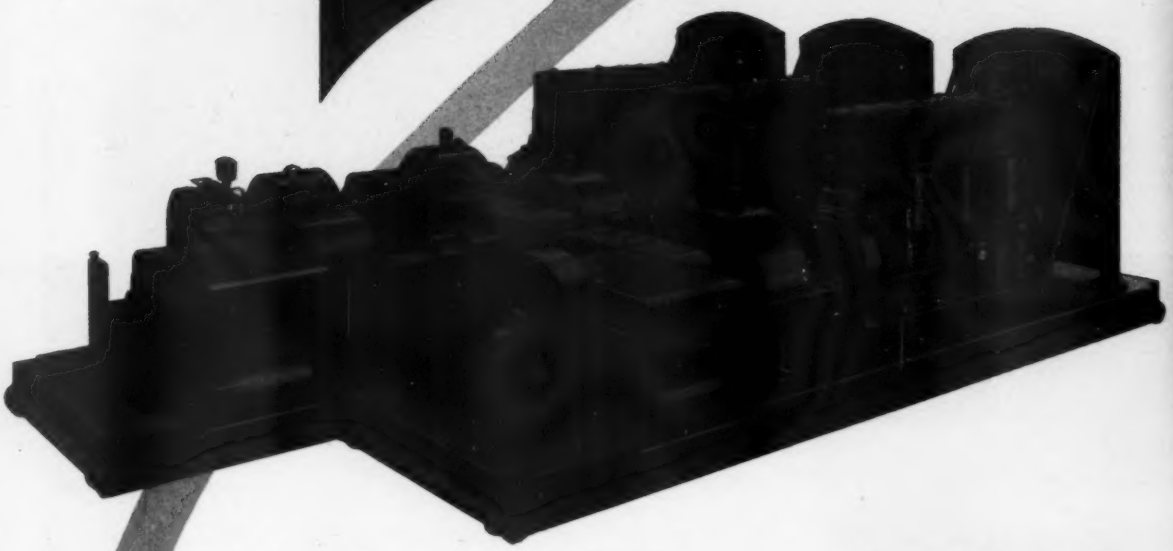
easy to move, always aligned...
"IDEAL" drive groups



Make up practically any rig power combination you prefer . . . there's an "Ideal" Sectional Drive Group that will fit your requirements.

Power it with 2 or 3 or 4 engines . . . drive one or 2 pumps . . . take your choice of torque converter, Gyrol fluid-drive, or conventional transmissions . . . use diesel, gas, or dual-fuel engines . . . whatever the combination, you'll drive your rig smoother, cheaper, more dependably with an "Ideal" Sectional Drive Group.

Each section of an "Ideal" group is a complete unit, from sturdy structural base to compounding elements. You can move it as a unit, with full assurance of accurate mating and alignment with other "Ideal" units. Assembly and disassembly can be done easily and quickly.

When you plan your rig drive, make it an "Ideal" Drive Group . . . be assured of factory-accurate alignment and maximum portability. May we send you bulletins describing "Ideal" Drive Groups?

THE NATIONAL SUPPLY COMPANY

GENERAL SALES OFFICES: TOLEDO, OHIO

NATIONAL BLUE PRODUCTS

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NATIONAL OIL FIELD MACHINERY AND EQUIPMENT . . . SPANG PIPE . . . SUPERIOR & ATLAS ENGINES

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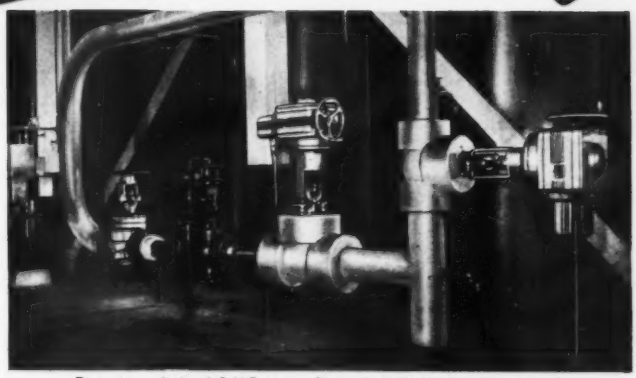
The Safe Sure Way to operate valves *Automatically*

The princ… unique Th… trolled Seati… feature of C-H TNY operators

During seating movement, Fulcrum is at A and drive is *down*, toward the valve seat. At moment of tight seating, Fulcrum transfers to B and further drive is *upward*, absorbed harmlessly by the springs to trip the Thrust switch and disconnect the motor.



Experience behind C-H Type TNY operators dates back to 1900, embraces every type of valve application.

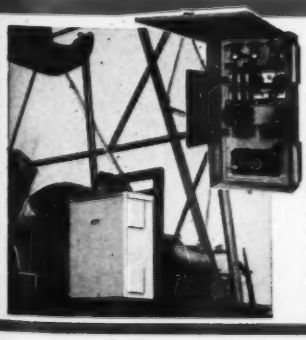
For valves which do not seat, such as the plug type valves, C-H B2 automatic declutching valve operators act swiftly and stop instantly.

THE problem of mechanized valve operation is the problem of *correctly* seating the valve. The danger is that either the disc is not completely seated, or that the driving force is not cut off soon enough with the result damaging stresses are set up throughout the assembly.

But Cutler-Hammer *Thrust Controlled* Valve Operators not only seat *all* valves under *any* circumstances exactly as they *should* be seated, but because of their ingenious design maintain that degree of tight seating without variation through expansion and contraction of valve parts under the extremes of heat and cold.

It will pay you to investigate Cutler-Hammer Motorized Valve Operators for any and every valve need. CUTLER-HAMMER, Inc., 1453 St. Paul Avenue, Milwaukee 1, Wisconsin.

OTHER CUTLER-HAMMER PRODUCTS FOR THE OIL AND GAS INDUSTRY



Long-lasting control that "schedules" oil well pumping

This Cutler-Hammer Motor Control Device built to the rigid requirements of tough oil country service automatically starts pump going and shuts it down in synchronization with oil well capacity or in conformity to operating schedule. You can set up any sequence of day and night operation, set it to skip certain days. Bulletin 9589D-21 tells all about this amazing pumping control. Send for free copy.

Know what you are buying, selling, giving away

These "gas counting" instruments tell you accurately

Cutler-Hammer Calorimeters . . . standard wherever gas is bought or sold—actually count the B. t. u.'s per cubic foot of the gas you are sending or receiving. Accurate within 1%. They also write a continuous 24-hour a day permanent record so you know at all times exactly what is going through your piping system . . . for accurate accounting and billing, and for accurate control of gas heating value. Free booklet "Where Experience Counts" tells all about C-H B. t. u. Control.

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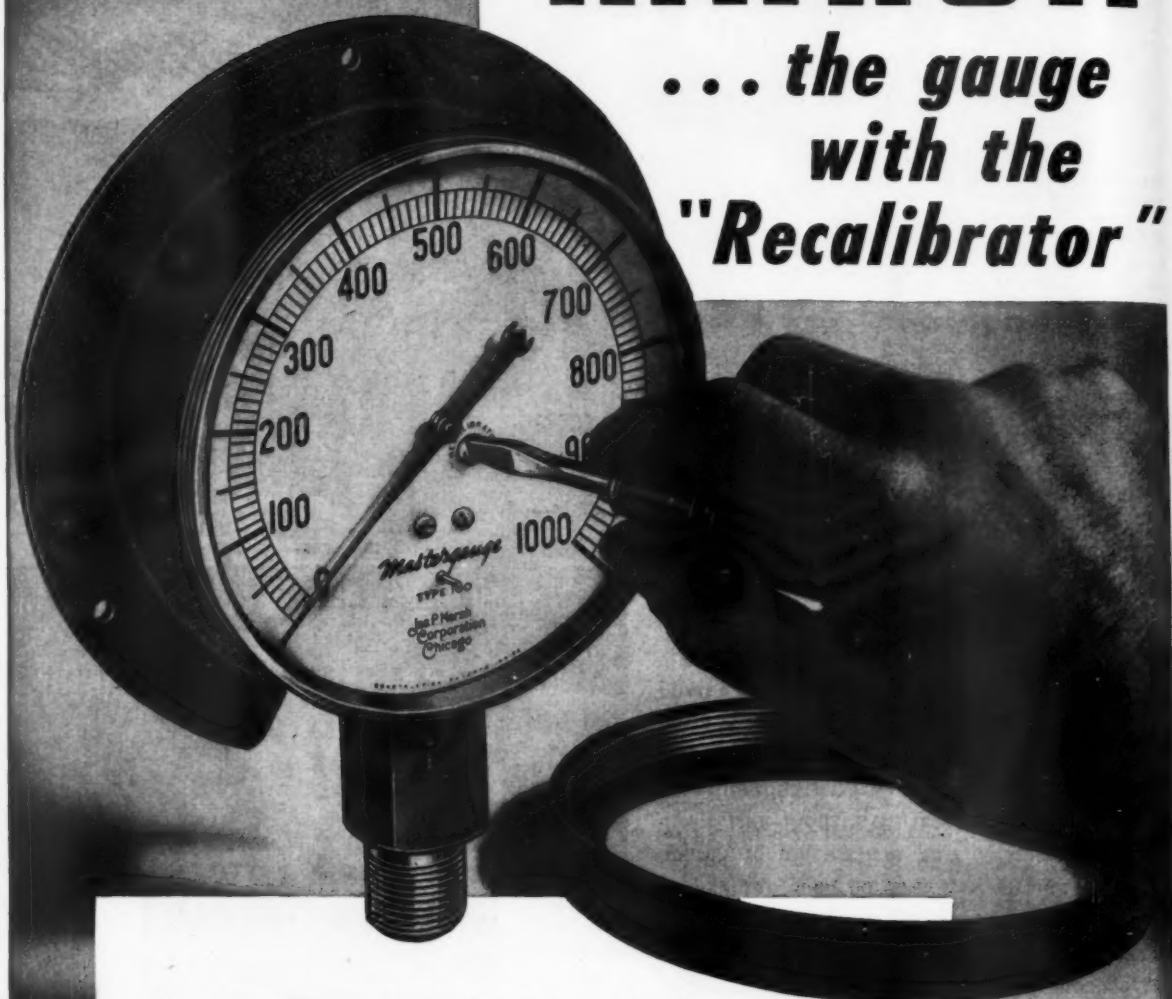
MARSH

. . . the gauge with the "Recalibrator"



Any pressure gauge can be knocked out of adjustment, but when it's a Marsh Gauge you can quickly correct it with the twist of the "Recalibrator" screw.

This is not only the handiest way to correct a gauge; it is also the best way. Conventional methods of adjustment simply compensate for the error. The "Recalibrator" corrects the relationship between the movement and the bourdon tube—actually *does re-calibrate* the gauge.

JAS. P. MARSH CORP., DEPT. L, SKOKIE, ILL.

Export Dept.: 155 E. 44th St., New York 17, N. Y.

The Marsh line includes gauges especially designed for blenders, boilers, burners, capping, Christmas trees, columns, heaters, hydrogen units, instrument panels, pumps, Reid vapor bombs, scrubbers, separators, mud pumps, stills, towers and other applications including oxygen and welding gauges. Ask on your letterhead for new catalog just off the press.

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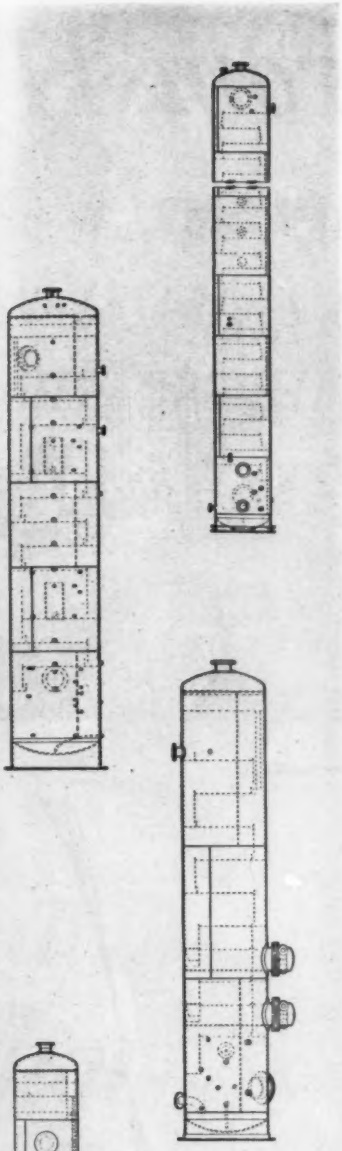
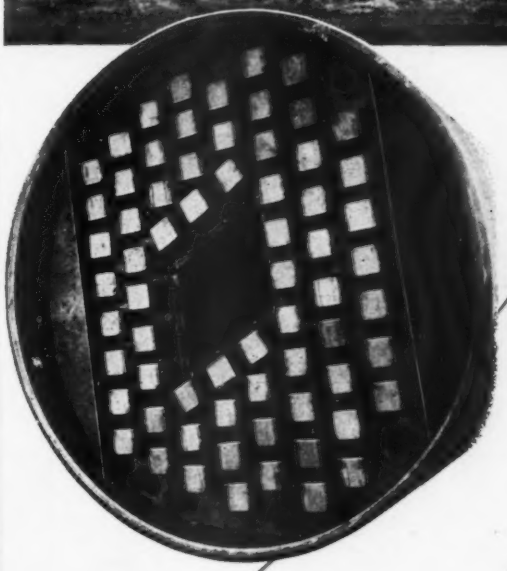


TULSA TYPE



The staggered arrangement of the bubble caps prevents channeling of the liquid on the tray.

TULSA TYPE Bubble Towers are BUILT RIGHT to accomplish the processing function required.

FLINT STEEL CORPORATION

TULSA, OKLAHOMA

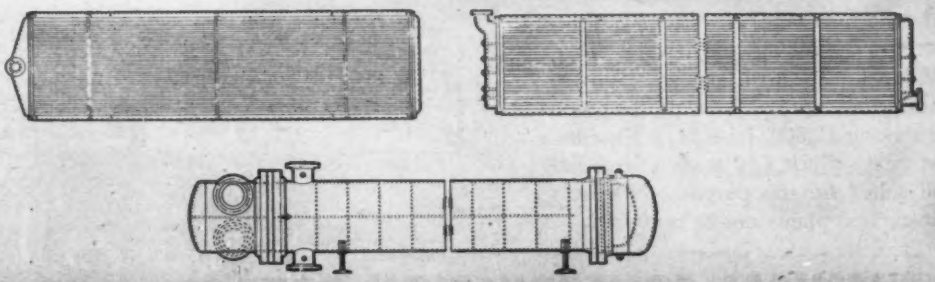


PLATE FABRICATING_____STRUCTURAL FABRICATING

REINFORCING FABRICATING_____WAREHOUSE PRODUCTS

XUM

Make H_2SO_4 from H_2S

WITH A CHEMICO PLANT

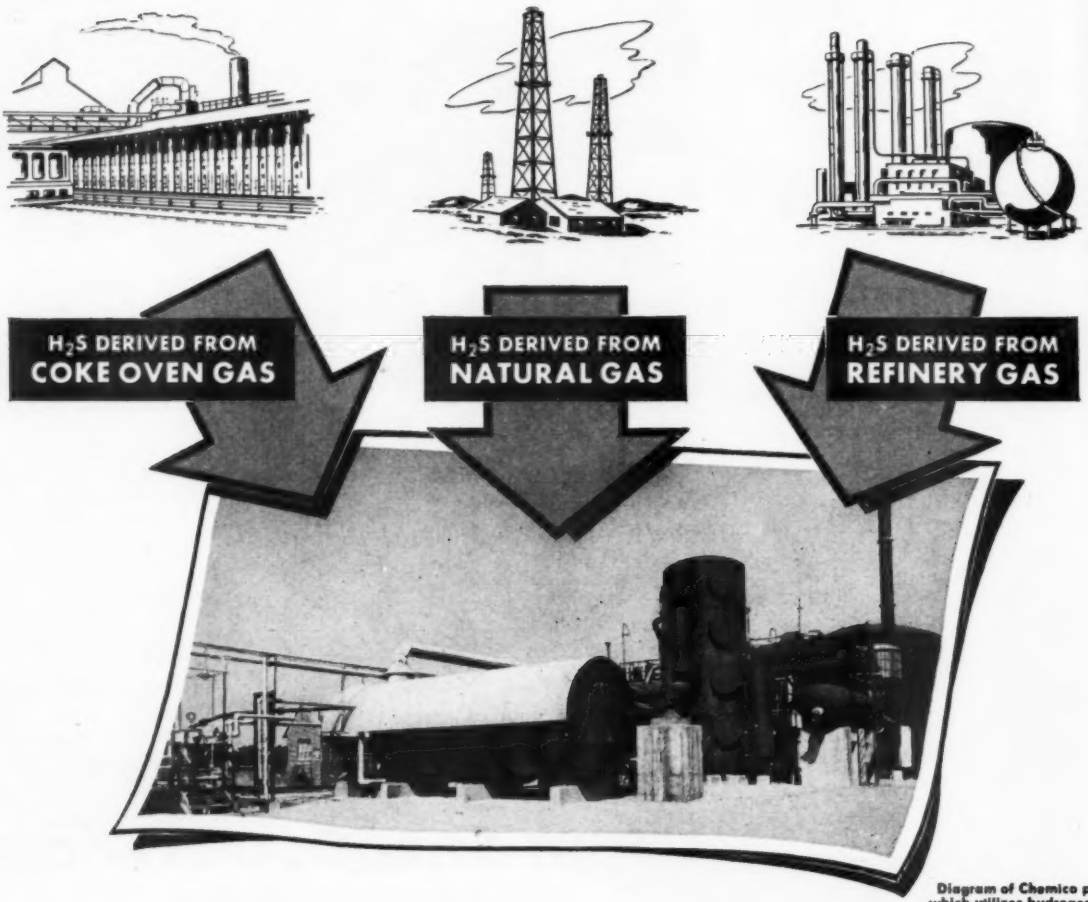
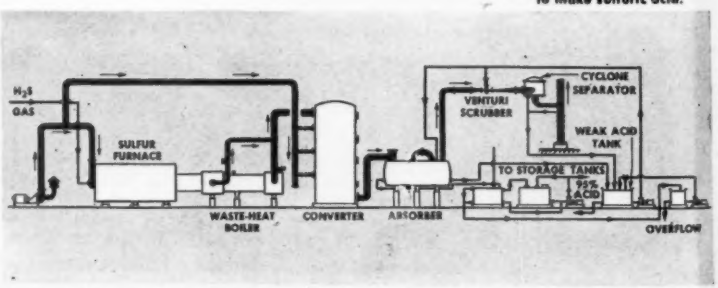


Diagram of Chemico process which utilizes hydrogen sulfide to make sulfuric acid.

Now that raw sulfur is in short supply, it has become necessary to manufacture sulfuric acid from other raw materials such as hydrogen sulfide. If you have hydrogen sulfide available, it will pay you to investigate Chemico's practical and proven process for making H_2SO_4 from H_2S. Chemico's new type sulfuric acid plant is especially well suited for this purpose. Or existing sulfuric acid plants can be converted.



CHEMICAL CONSTRUCTION CORPORATION

A UNIT OF AMERICAN CYANAMID COMPANY

488 MADISON AVENUE, NEW YORK 22, N. Y.

EUROPEAN TECHNICAL REPRESENTATIVE: CYANAMID PRODUCTS, LTD., LONDON W. C. 2, ENGLAND
CABLES: CHEMICONST, NEW YORK

CC219

Chemico plants are profitable investments

It Has Everything

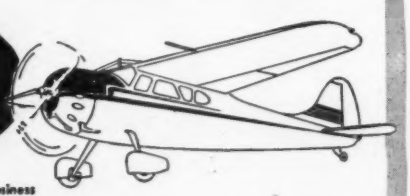
4-PLACE—ALL-METAL—SPEED

ROOM—LUXURIOUS CABIN—HIGH WING STABILITY

...at a Price Several Thousand Dollars Lower THAN ANY OTHER 4-PLACE ALL-METAL PLANE ON THE MARKET

On Display at Your Cessna Dealer's...

Cessna 190 SERIES



The perfect answer for big or small business firms, because this wonderful ship carries five people at over 160 m.p.h., yet is simple, practical, comfortable to operate. Airline-type engines and Hamilton Standard Constant Speed Propellers.

Ride the Cessna 170* in comfort . . . four roomy, (adjustable) foam rubber seats . . . large luggage compartment for long trips.

You cruise serenely at over 120 m.p.h., squeeze over 15 miles out of a gallon of gas, fly 500 miles nonstop. Maintenance is easy and inexpensive.

Talk normally during flight . . . unique engine mount, improved insulation and door seal reduce both noise and vibration unbelievably.

Get stable "big ship" feel, "small ship" responsiveness—with perfected tapered semicantilever high-wing design. Land on short fields—with selective-action 50° flaps, adjacent trim control, picture-window visibility. Set down softly on rough terrain—with easy-action nonfade brakes and patented shock-absorbing landing gear.

The Cessna 170 is a luxurious cabin cruiser yet can be an aerial "jack-of-all-trades." Remove rear seat in three minutes for cargo-type luggage space, or equip it with: skis for use on snow . . . seaplane floats for use on water . . . cross-wind wheels for single-strip all-wind conditions . . . a stretcher for ambulance service . . . spraying equipment for crop-protection work.

Cessna 170

MAIL THIS COUPON NOW:

Cessna Aircraft Co.
Dept.OG-1Wichita, Kansas
Please send free literature giving complete description of the Cessna 170.

Name_____

Address_____

City_____ State_____

Firm Name_____

Phone No._____

** During 1950, the Cessna 170 outsold all other four-place airplanes, regardless of price.*

ANNOUNCING
A BRAND NEW CATALOG
FOR BONNEY WELDOLETS

Contains complete and up-to-the-minute catalog information on all types of Weldolet welding fittings available. Presents a full range of sizes and schedules, introducing many new applications, together with simplified data on the determination of code requirements. To get your copy of this catalog, write . . .

BONNEY FORGE & TOOL WORKS
366 Green Street, Allentown, Pa.

Export Distributor
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30 Rockefeller Plaza, N. Y.

WELDOLETS

WELDING FITTINGS FOR ANY PIPING SERVICE

ACIPCO

When you buy anything, you want the best quality you can get for your money. Our trade-mark cast on our products gives you this assurance. The trade-mark "ACIPCO" means the materials used in manufacturing our pipe are warranted to be first class and the workmanship is guaranteed to be of finest quality.

As America's largest individual cast iron pipe foundry, ACIPCO manufactures a complete line of cast iron pipe and fittings in diameters from 3″ to 48″, inclusive. The pipe which is made by the Mono-Cast centrifugal process is equipped with any of a wide variety of joints including Bell and Spigot, Doublex Simplex, Molox Ball and Socket, Roll-On-Rubber Ring, Screw-Gland, and Flanged. All ACIPCO pipe is manufactured under close control to meet nationally recognized standard specifications.

Being cast iron, ACIPCO pipe enjoys an enviable reputation. Cast iron pipe has had over three hundred years of service abroad and more than one hundred years of service in the United States. It serves equally well beneath crowded city streets or in cross country installations.

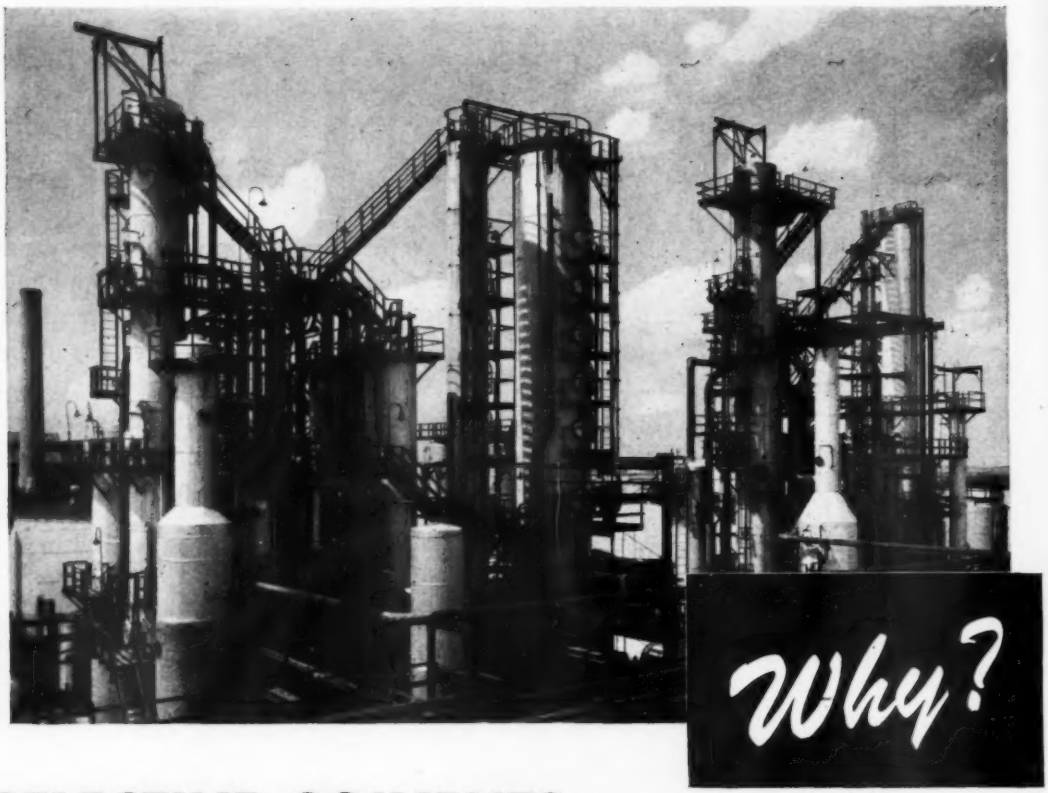
Address ACIPCO office nearest you.

AMERICAN CAST IRON PIPE COMPANY

Birmingham 2, Alabama

Dallas Houston El Paso Pittsburgh Kansas City New York City
Chicago Minneapolis Cleveland Los Angeles San Francisco Seattle

Industry selects Furfural



SELECTIVE SOLVENTS

It is enlightening to examine the reasons why furfural has been chosen for so many applications involving solvent extractions.

(1) Furfural is a polar molecule and gives a sharp separation between many closely related compounds. Its specific gravity permits rapid separation.

(2) Furfural is a very stable compound and may be recovered almost quantitatively for reuse.

(3) This solvent is easy to handle and safe to use.

(4) The furfural is produced in large quantities from replaceable raw materials and is consistently low in price.

As a selective solvent, furfural is now used in treatment of wood rosin to remove color bodies; in extraction of lubricating oils and furnace oils to eliminate sludge forming materials; in refining of diesel fuel to raise cetane values and in processing of glyceride oils to separate drying from non-drying portions. In a modified technique, it is used as an extractive distillation agent for separating C-4 hydrocarbons.

Many mixtures lend themselves to selective solvent refining. If you would like to know more about the techniques employed, write for our Bulletin SS.

The Quaker Oats Company CHEMICALS DEPT.

3398 THE MERCHANDISE MART
CHICAGO 54, ILLINOIS
NEW YORK, 12368 WHITEHALL BLDG., New York 4, N.Y.

In San Francisco, The Griffin Chemical Company • In the United Kingdom, Imperial Chemical Industries Ltd., Billingham, England • In Australia, Swift & Company, Pty. Ltd., Sydney • In Europe, Quaker Oats-Graanproducten N. V., Rotterdam, The Netherlands; Quaker Oats (France) S. A. 42, Rue Pasquier, Paris 8E, France. In Japan, F. Kanematsu & Co., Ltd., Tokyo.

"We all use seamless for drill pipe — and it's best for casing and tubing, too!"

● Nobody takes chances on drill pipe. Failure is simply too expensive. Drill pipe is made only in *seamless* because drillers know that all-seamless construction is the *only* construction that has the high safety margin necessary for tough drilling jobs.

The same advantages apply to seamless *casing* and *tubing*. It's the one sure way to get uniform wall strength, smooth make-up, tough joints and high collapse resistance.

All National Tube Company Drill Pipe, Casing, and Tubing is seamless. Each tube is pierced from a billet of fine steel. This piercing operation is one of the most drastic forming operations in the steel business—but it gives the strongest, most dependable tubular section that money can buy.

When planning for future strings of oil country tubular goods, remember the advantages of all *Seamless* construction. You can't buy anything better.

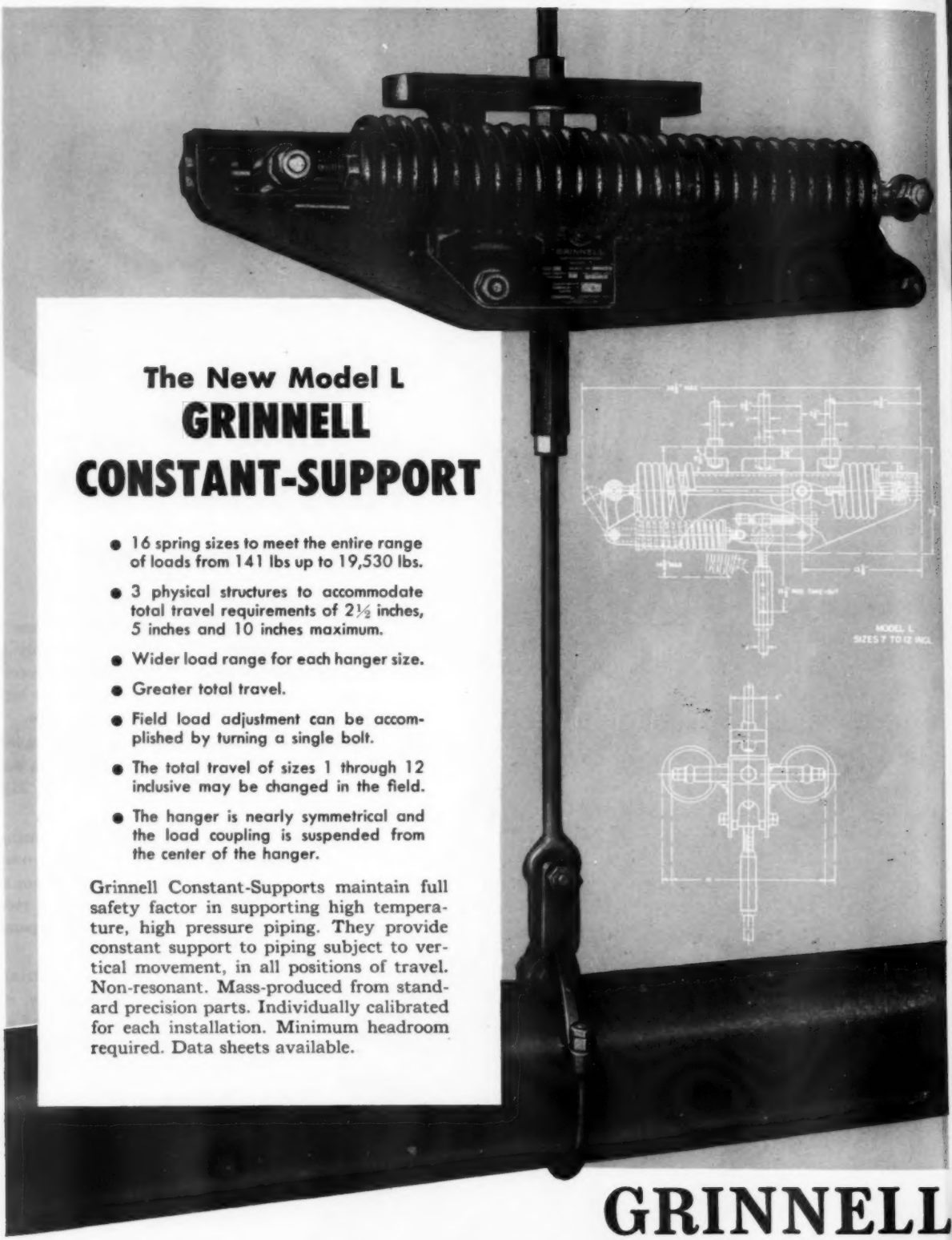
WALLS WITHOUT WELDS

NATIONAL TUBE COMPANY, PITTSBURGH, PA.
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS

NATIONAL SEAMLESS PIPE AND TUBES

UNITED STATES STEEL



The New Model L
GRINNELL
CONSTANT-SUPPORT

- 16 spring sizes to meet the entire range of loads from 141 lbs up to 19,530 lbs.
- 3 physical structures to accommodate total travel requirements of 2½ inches, 5 inches and 10 inches maximum.
- Wider load range for each hanger size.
- Greater total travel.
- Field load adjustment can be accomplished by turning a single bolt.
- The total travel of sizes 1 through 12 inclusive may be changed in the field.
- The hanger is nearly symmetrical and the load coupling is suspended from the center of the hanger.

Grinnell Constant-Supports maintain full safety factor in supporting high temperature, high pressure piping. They provide constant support to piping subject to vertical movement, in all positions of travel. Non-resonant. Mass-produced from standard precision parts. Individually calibrated for each installation. Minimum headroom required. Data sheets available.

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WHENEVER PIPING IS INVOLVED

GRINNELL COMPANY, INC., Providence, R. I. Warehouses: Atlanta • Billings • Buffalo • Charlotte • Chicago
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Oakland • Philadelphia • Pocatello • Sacramento • St. Louis • St. Paul • San Francisco • Seattle • Spokane

We're helping break up this

VICIOUS CIRCLE

THE more steel America produces the more machines are made—that means we need more gasoline, fuel oils and lubricants to operate the machines—so we need more steel to drill wells and to build pipe lines and refineries to provide the petroleum products to keep the machines running. It becomes a vicious circle—but we're helping break it up.

McKee Company's Iron and Steel Division is assisting materially in increasing iron and steel producing capacity—and thereby petroleum producing and refining capacity. McKee has in process of design, engineering and construction 6 Blast Furnaces, 2 Integrated Steel Plants, 1 Open Hearth Plant, 6 Major Petroleum Refinery projects and some 50 miscellaneous projects.

McKee's combined, world-wide experience and broad services to these two basic industries—steel and oil—continue to prove advantageous to both.

ARTHUR G. McKEE & COMPANY

ESIGN, ENGINEERING AND CONSTRUCTION FOR THE PETROLEUM REFINING AND IRON AND STEEL INDUSTRIES

ENGINEERS AND CONTRACTORS • ESTABLISHED 1905
2300 CHESTER AVENUE, CLEVELAND
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300 BBL. PER DAY FROM 11,140 FEET

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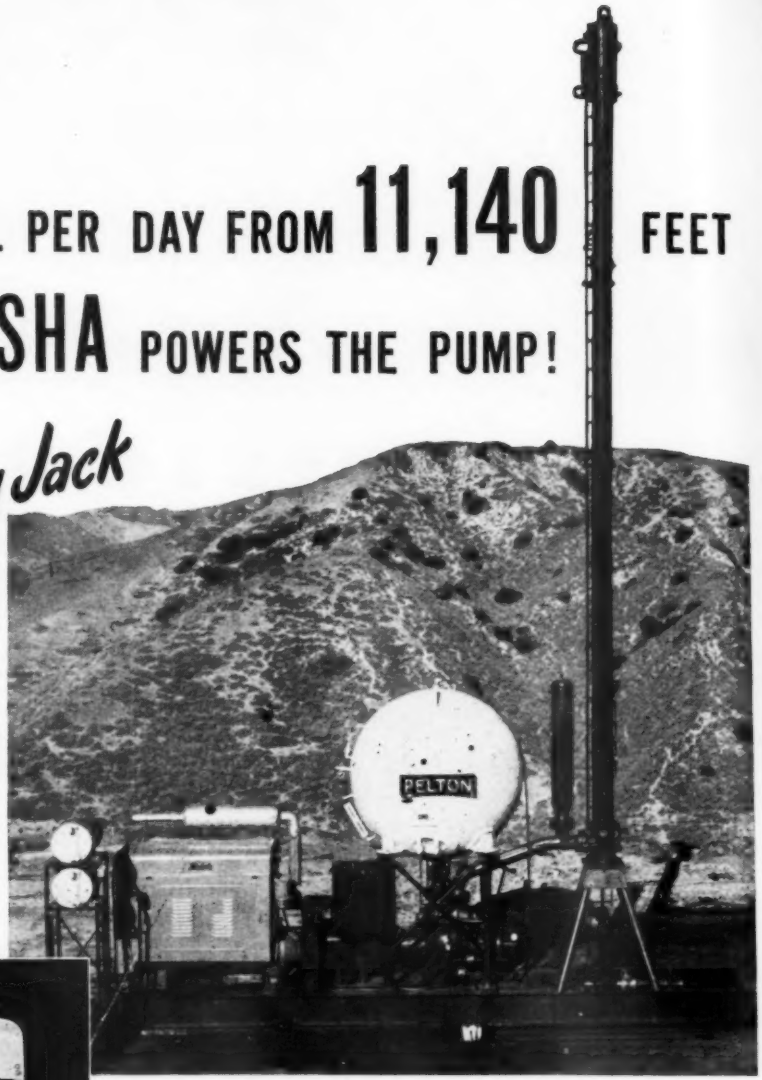
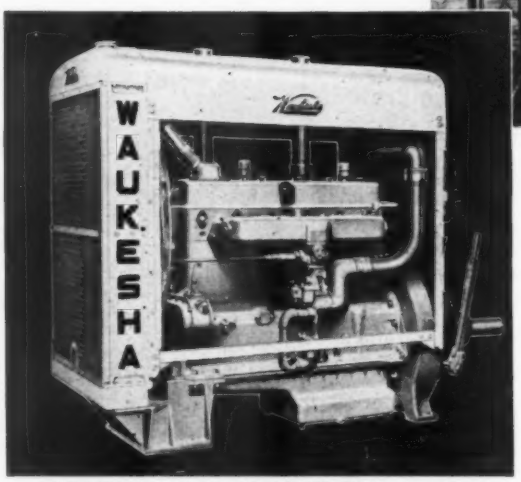
Pelton Pumping Jack carries 40,000 lb. load with 30 ft. stroke





WAUKESHA Super Duty Six (Model 6-WAKU) Gas Power Unit— six cylinders, 6¼-in. x 6½-in., 1197 cu. in. displacement.

● Deep well pumping! That calls for powerful pumps . . . and dependable power plants to keep 'em pumping. Here you have it. And it's Waukesha power, as usual. It's in the Ventura Avenue Field, California—where one of the major oil companies is using this Model 512-9-30C-P *Pelton* hydraulic pumping jack, powered with a Model 6-WAKU Waukesha. With the 1½-in. pump set at 11,140 feet it is pumping 300 barrels per day. That's carrying a 40,000 lb. polished rod load with a 30-ft. surface stroke. You'll find the Waukesha Super Duty Six (6-WAKU) power unit in every oil field—pumping, or drilling, or servicing. It burns natural gas and butane, or gasoline. It has a maximum continuous output of 170 hp at 1300 rpm on 1000 btu natural gas. And it is as flexible as it is reliable. Cost less to run and maintain, too. Details? Get Bulletin 1139.

WAUKESHA MOTOR COMPANY, WAUKESHA, WIS.

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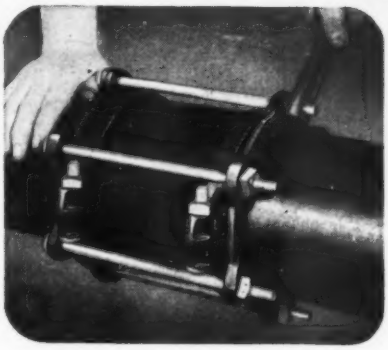
118

WAUKESHA *Gas Power* *Diesel Power* ... POWER

FOR THREAD LEAKS AT FITTINGS



FOR EVERY TYPE OF COLLAR LEAK

SKINNER-SEAL COLLAR LEAK CLAMP, with its sealed *gasket* and massive construction, stops every type of collar leak.

SKINNER-SEAL PIPE JOINT CLAMP stops leaks at joints where pipe is screwed into a fitting. Any temperature — pressures up to 2,000 pounds. A permanent repair — it saves the cost of tearing out and renewing leaky fittings. Prevents shut-downs. In universal use for over half a century. In stock at all Oil Well Supply Stores!

M. B. SKINNER COMPANY, SOUTH BEND 21, IND., U. S. A.

PIPE JOINT CLAMP
COLLAR LEAK CLAMP

SKINNER-SEAL

LONG LASTING

Condor V-BELTS

"We don't have to buy belts so often since we started using Condor Whipcord V-Belts," say users, "and we save on maintenance, need less inventory, and with all, get better power transmission!"

Long life is built right into every Condor V-Belt. Therefore, these belts have less stretch on your drive, don't require take-up so often. And the engineered straight sidewalls grip pulleys snugly and deliver positive power. All the advantages are described in Bulletin 6868 D, mailed on request. You'll find our hose, flat belting and conveyor belts last longer, too. Phone your R/M Distributor.

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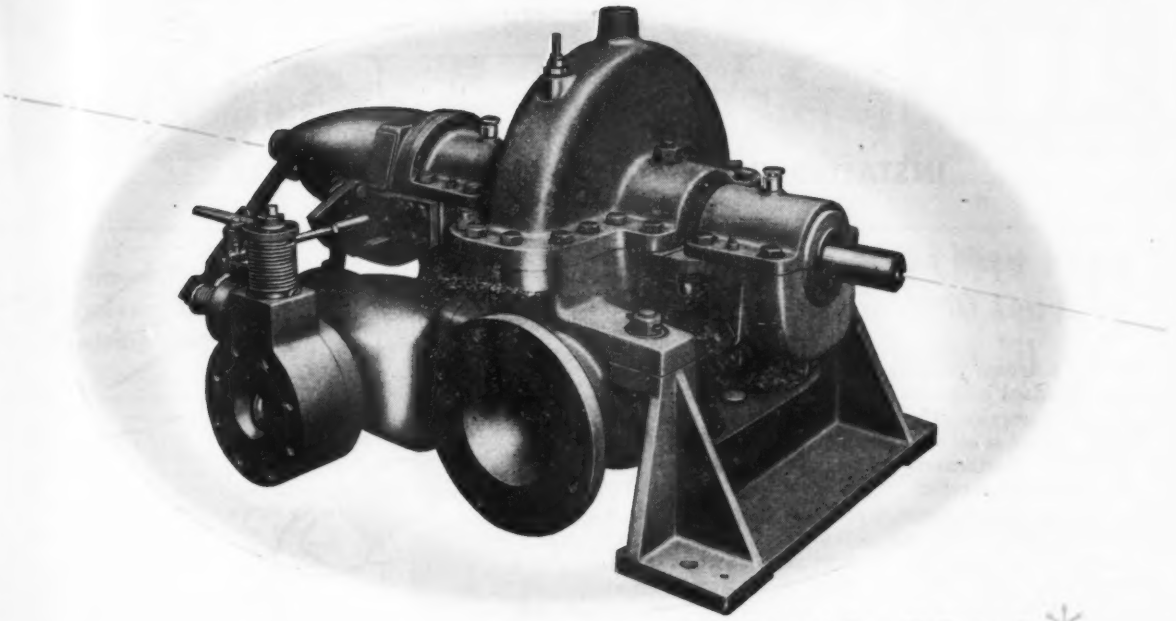
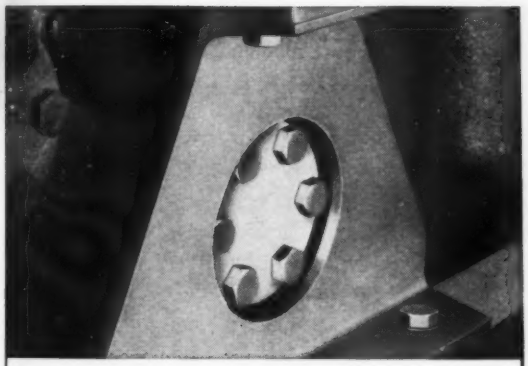


Alignment that STAYS TRUE* when the heat's on!



Three-Way Centerline Support

* The Type E method of support allows three-way freedom of expansion and contraction without disturbing the alignment of the rotor shaft. The governor end is mounted on a strong but flexible channel beam to permit axial expansion. At the shaft-coupling end, a unique keyed support connects to the turbine near the shaft centerline to permit lateral expansion; and a vertical kingpin transmits thrust from the expanding steam pipes directly to the foundation and not to the turbine. The casing is free to move vertically with expansion or contraction.

Heat expansion can't disturb Type E alignment. The operation of driven equipment is easier, more dependable—installation costs are reduced. Westinghouse unique *three-way centerline support* keeps alignment perfect with the driven machine. Strong supports at both the governor and exhaust ends are supplemented by a vertical kingpin that transmits lateral thrust to the foundation. Hot or cold—for constant operation or instant stand-by power, you can depend on the Type E Turbine to "Stay True"!

There are other cost saving advantages, too. Dual protection against overspeed, weatherproof bearing seals, corrosion-resisting gland zones, floating movement of governing and trip linkage, and parts interchangeability between wheel sizes are just a few.

For the full story ask your nearby Westinghouse Steam Specialist for the Type E Turbine Book B-3896, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-50520

YOU CAN BE SURE.. IF IT'S
Westinghouse
TYPE E Turbines

ALL OF THE FARREL SPEED INCREASERS

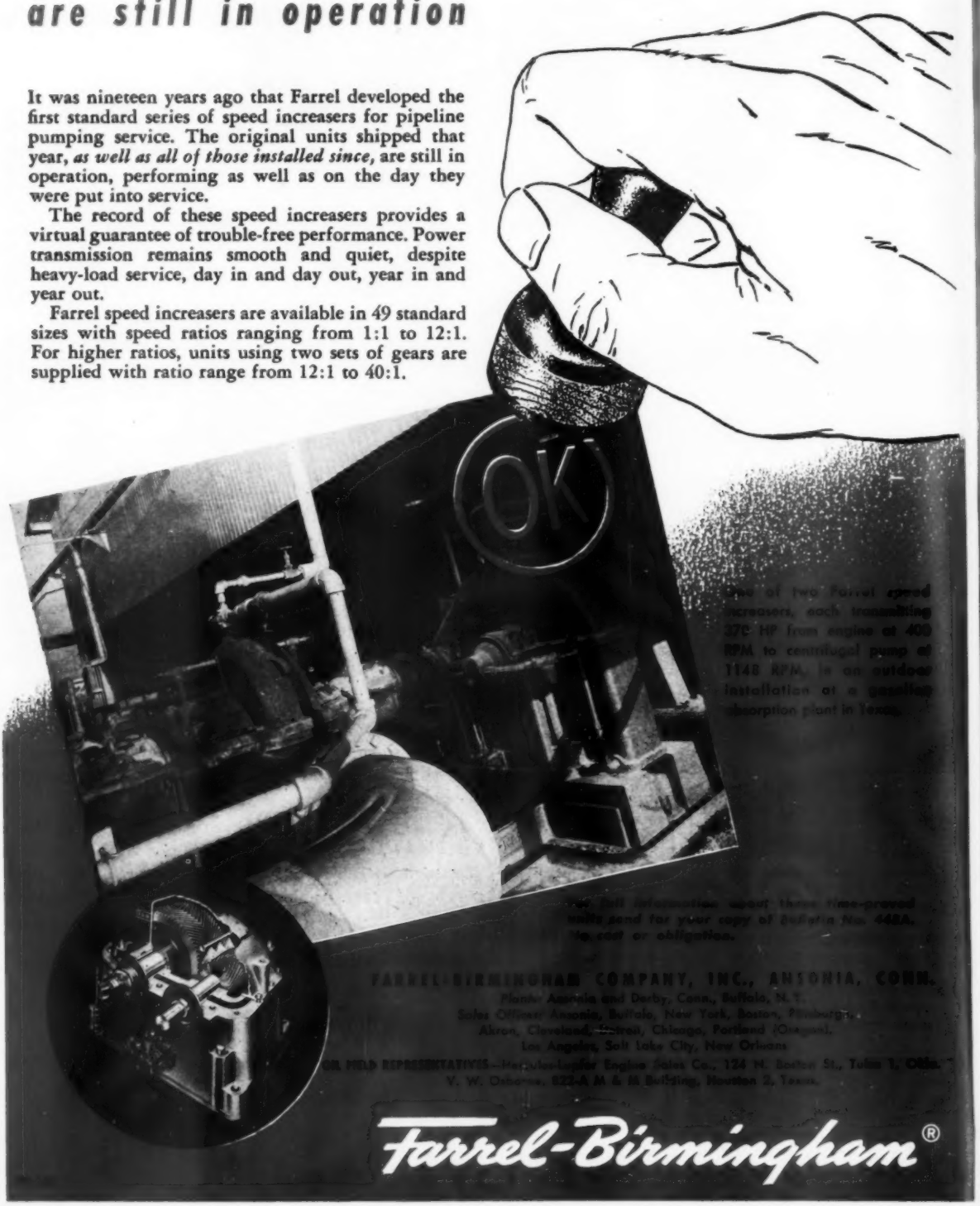
INSTALLED IN THE OIL INDUSTRY SINCE 1932

are still in operation

It was nineteen years ago that Farrel developed the first standard series of speed increasers for pipeline pumping service. The original units shipped that year, *as well as all of those installed since,* are still in operation, performing as well as on the day they were put into service.

The record of these speed increasers provides a virtual guarantee of trouble-free performance. Power transmission remains smooth and quiet, despite heavy-load service, day in and day out, year in and year out.

Farrel speed increasers are available in 49 standard sizes with speed ratios ranging from 1:1 to 12:1. For higher ratios, units using two sets of gears are supplied with ratio range from 12:1 to 40:1.



One of two Farrel speed increasers, each transmitting 270 HP from engine at 400 RPM to centrifugal pump at 1148 RPM, in an outdoor installation at a gasoline absorption plant in Texas.

For full information about these time-proved units send for your copy of Bulletin No. 448A. No cost or obligation.

FARREL-BIRMINGHAM COMPANY, INC., ANSONIA, CONN.

Plants: Ansonia and Derby, Conn., Buffalo, N. Y.

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FIELD REPRESENTATIVES—Hercules-Legion Engine Sales Co., 124 W. Boston St., Tulsa 1, Okla. V. W. Osborne, 822-A M & M Building, Houston 2, Texas.

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DU PONT REG. U.S. PAT. OFF.

PETROLEUM CHEMICALS DIVISION

NEWS

DU PONT REG. U.S. PAT. OFF.

March ★ One of a Series of Interest to the Petroleum Industry ★ 1951

Additional Facilities For Petroleum Laboratory Nearing Completion

The Du Pont Petroleum Laboratory, devoted to fundamental research and technical development on chemical additives for fuels and lubricants, will soon increase its laboratory facilities by approximately 50%. Work on the expanded facilities started about a year and a half ago. Some units are now in operation and it is expected all will be functioning by late spring.

The expansion, located principally in a new building, will add considerably to the laboratory floor space and will permit greatly increased activity in the petroleum chemicals research program which originated about three years ago.

Tel Tank Car Unloading Simplified by Du Pont-Designed Metal-Flex Hose Line

Conventional pipe lines with swing joints for loading and unloading TEL tank cars have never been completely satisfactory. Keeping the joints properly packed so as to prevent the escape of dangerous tetraethyl lead or "lead" fumes always presented a safety and maintenance problem. Repacking such joints frequently tied up three or four pipefitters for an entire day.

Even when properly maintained, there was no assurance that joints would be tight and unloading difficulties were often encountered due to leaks. Swing joints that did not leak were usually so tightly fitted that the operators had difficulty in manipulating them into position. This cost both time and effort.

Du Pont recognized the cost and hazards associated with the maintenance of such lines and designed a metal-flex hose which eliminates swing joints altogether.

Complete flexibility of this hose is obtained through the use of a flexible metal tube which is strengthened by braided wire mesh to withstand pressures up to 100 lbs. per sq. in.

Customers report the following advantages:

1. Greater ease in connecting up the tank car. Only one man required where, with the old style, two men were frequently needed.
2. Freedom from leaks which cause unloading difficulties.
3. Complete elimination of expense and hazards connected with repacking the old type swing joint.

Du Pont standard drawings and specifications now include the flexible type hose as standard equipment. The operation of replacing the old type line and swing joints with metal-flex hose is simple and inexpensive. The Company can make the hose available through its Petroleum Chemicals Division District Offices and is happy to furnish the necessary engineering service.

Success of National Tour of Du Pont Road Octane Fuel Test Fleet in 1950 Leads to Expansion of Activity for '51

Back in May 1950, Du Pont began a new kind of experiment. It originated around three highly instrumented automobiles. These were designed to show that road octane tests could be conducted with a neatness and dispatch hitherto not often practiced in the petroleum field.

Test cars Nos. 29, 30 and 31 shined up for the 1950 cross-country tour. Du Pont men in the foreground are Harold Russell, Carl Ferris and Ray Spender discussing the route to be taken to the next day's demonstration.

In the course of a few months the cars toured the country from coast to coast giving test demonstrations to refinery personnel everywhere. At the end of their trek each of the cars, an Oldsmobile, a Plymouth and a Chevrolet, had covered some 23,000 miles.

Out of 236 petroleum company headquarters and division offices contacted before and during the tour, 233 indicated an interest in the project and requested that presentations or demonstrations be made to their personnel. The showings varied from private viewings of the cars in big-city hotels including formal talks or round-table discussions, to road demonstrations at refineries situated many miles away from the nearest town.

There was nothing new in the actual instrumentation of the demonstration cars. But the convenient way Du Pont engineers arranged it on the dashboard, and especially the ease achieved in changing from one fuel to another by the simple manipulation of push buttons, showed that road octane testing did not necessarily have to be the somewhat crudely conducted chore so many had thought it to be.

And that is what appealed especially to most of the 3,144 petroleum men who saw these cars in 1950. It is also the reason for the augmented fleet planned in 1951.

OVER

ADVERTISEMENT — Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

DU PONT

PETROLEUM CHEMICALS DIVISION NEWS

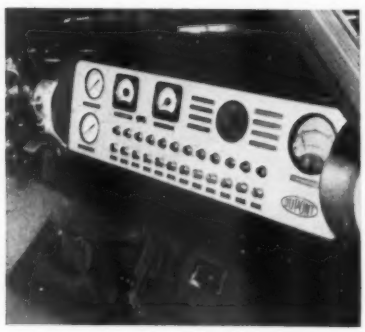
DU PONT

CONTINUED Fleet Tour

The three original cross-country cars have been torn down, examined, checked, reassembled and restored to perfect running order. Two were subsequently sent to Florida on a brief tour along the Plantation Pipe-line. The third was driven to the Chicago territory where it is being used by various petroleum companies as an aid in dealer training.

Soon four more cars will be added to the fleet. These will be the latest models of Packard, Buick, Ford and another Oldsmobile. They will be instrumented in much the same way as the three original cars.

But the seven road test cars, this time, will not go on tour. Instead one, or two, will be assigned to each of the five Du Pont Petroleum Chemicals District Offices where they will be made available to refiners, laboratories or marketing groups for educational or demonstration purposes.



The instrument panel of the test cars is designed to blend with the original dashboard. The push buttons for venting, for tank fuel, and for reference and test fuels are in line on the lower part of the panel. Red warning lights indicate the fuel being used.

For those organizations who desire to build similarly instrumented road octane test cars of their own the Du Pont Company will be happy to supply specifications and photographs. The Company will also give, wherever possible, such personal technical assistance as may be needed to place the cars in operation.

With the advent of the new cars, Nos. 39 to 42, this will bring to forty-two the number of cars and trucks that have operated in the Du Pont Petroleum Chemicals Division test fleets. Of this number twenty-eight are in active operation today.

Aviation Specialist on Staff of Petroleum Chemicals Division

JOHN R. GRIFFIN, JR. joined the technical staff of the Du Pont Petroleum Chemicals Division in July 1950, and now specializes in fuel and lubrication problems connected with aviation. He holds a Master's degree in engineering.

After a year of teaching at the University of Texas, he joined the Lockheed Aircraft Company where he engaged in the structural testing of planes including many of the tests which prepared the now famous P-38 for flight. In 1941 he joined the Shell Development Company to work on lube oil development for 2½ years. From 1943 to 1949 he was with Trans World Airlines handling maintenance problems. During his last four years with TWA he was in charge of engineering for over-ocean operations at New Castle Airport, Delaware. He came to Du Pont from the Sharples Corporation where he was chief engineer in the research laboratory.

At present, Griffin spends most of his time conferring with airlines regarding present and future developments of the various types of aircraft propulsion units and fuel requirements for these units.

Du Pont Spray Glaze

New Car Polishing Product Saves Time and Labor

Attractive new SPRAY GLAZE container belongs to famous Du Pont No. 7 Line of products.

SPRAY GLAZE, a new protective coating and polish for automobile finishes was brought out by Du Pont in 1950. Formulated to be applied with a special spray gun, Du Pont SPRAY GLAZE is for use by service stations, car dealers, body shops and fleets. It produces a higher lustre than waxes and requires less time and labor to apply.

After the car finish has been thoroughly cleaned, SPRAY GLAZE is applied by air gun over the entire surface in a matter of a few minutes. Final polishing is easily and quickly done by hand with clean dry cloths. Because of the nature of SPRAY GLAZE, hard rubbing is not necessary.

LITERATURE AVAILABLE

The Petroleum Chemicals Division of Du Pont has published a wide variety of material of interest to the petroleum industry. This includes technical papers, bulletins, reports and memoranda as well as equipment operation bulletins, safety regulations, tank cleaning data, marketing aids and the like.

Any of this is available on request to your nearest Du Pont Petroleum Chemicals Division District Office. A partial listing of available material is shown below:

Tank Talk—A new 52-page booklet designed for easy reading by tank cleaning personnel . . . . . Serial A-1134

Blending calculator for Du Pont TEL Compound (Aviation Mix) . . . . . Serial A-1210

Exhaust Valve Rotation—A resume covering the use of mechanical devices to improve valve life . . . . . Serial A-656

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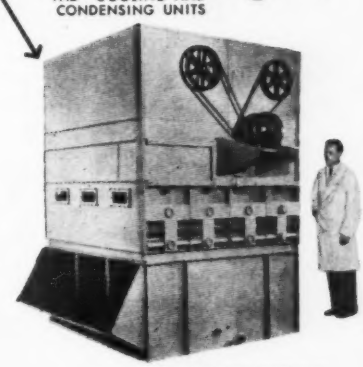
Why not profit from the convenience and economy of single-source ordering? Make that source Young. The coupon, below, will bring further product information and the name of your nearest Young Representative.

"VAD" COOLING AND CONDENSING UNITS



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Please send information on the Young Products checked below; also name and address of your nearest representative.

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- ☐ "VAD" Cooling and Condensing Units
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XUM

How to design PRODUCTS WITH A SUCCESSFUL FUTURE

There's no greater assurance of a useful and profitable future for your product than the selection of Clark products as components. Their own successful future depends squarely on how capably they serve you.

One main reason why "Working with Clark" appeals strongly to leading heavy equipment manufacturers is Clark's endless engineering study and search for ways to "make and do it better."

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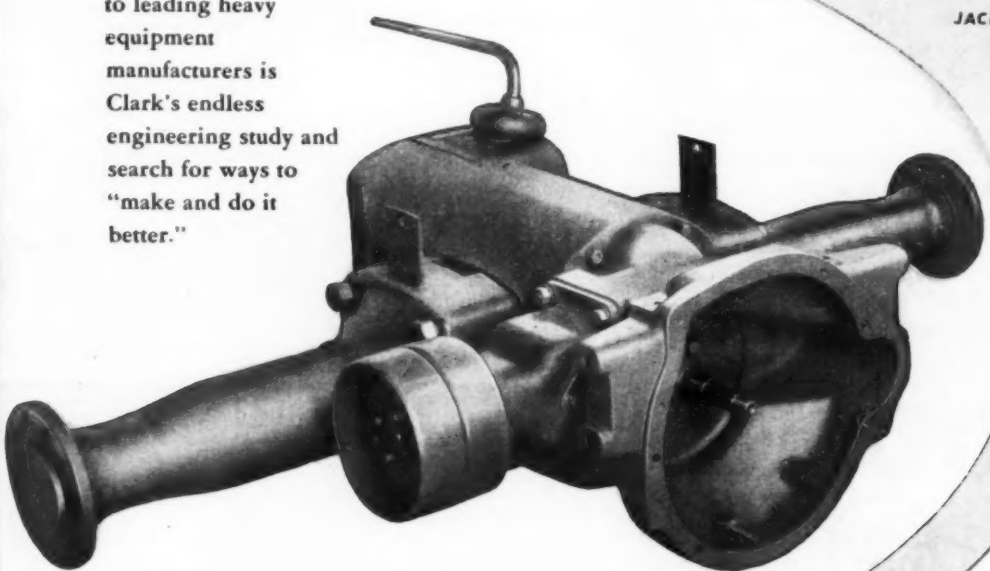

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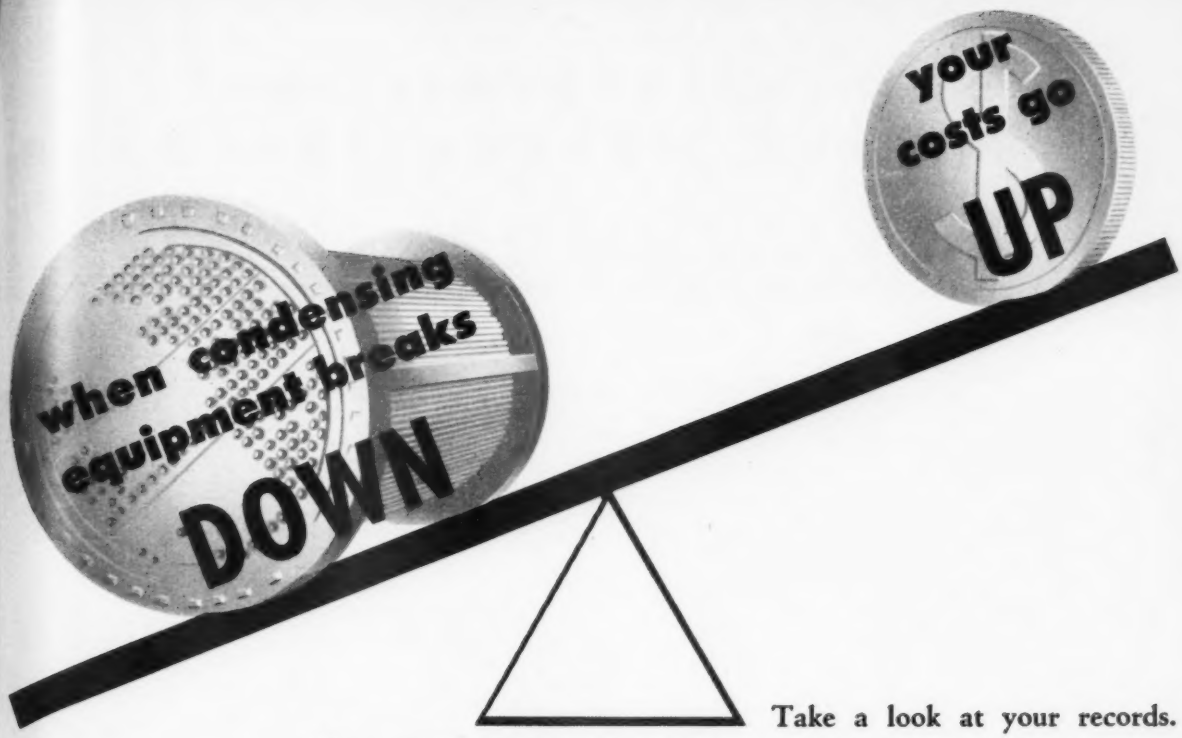

Take a look at your records. How much productive time did you lose through shutdowns necessitated by retubing?

Wouldn't it be worth your while to review your situation with technical men whose specialized knowledge and experience enables them to select plain or finned tube of the proper alloys that are particularly adapted to the applications at hand—just to make sure that the tube you are using best suits your specific application?

We should like to suggest that you avail yourself of the wealth of helpful information that is here in our Customers' Engineering Service. You will find it to your interests to consult with us—particularly now when you, along with all the rest of us, are endeavoring to conserve the materials and get the most efficient performance from the present equipment.

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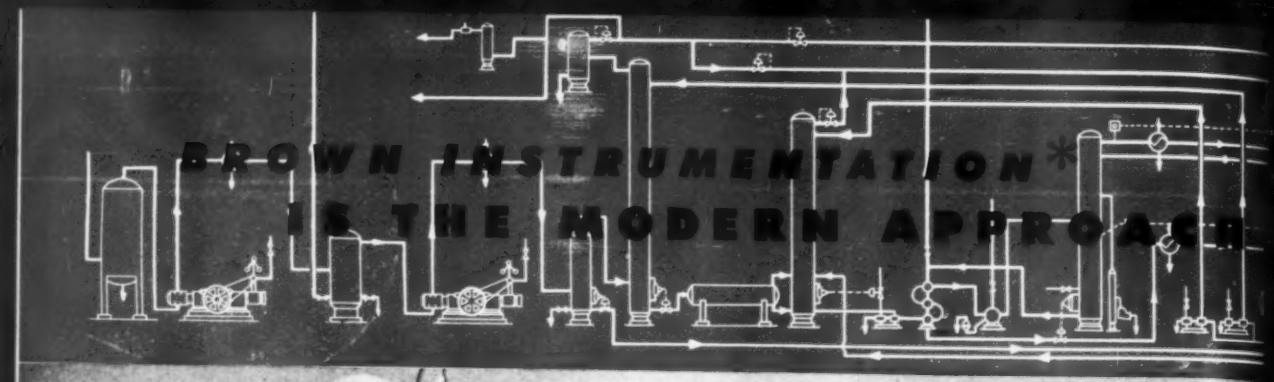

BROWN INSTRUMENTATION*
IS THE MODERN APPROACH

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PLANT DESIGNED
FOR PROCESS
SIMPLIFICATION
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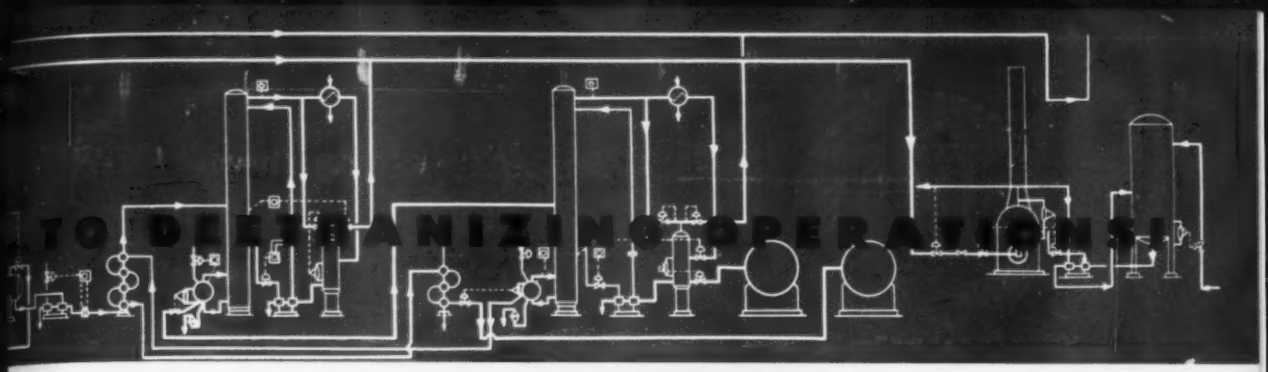
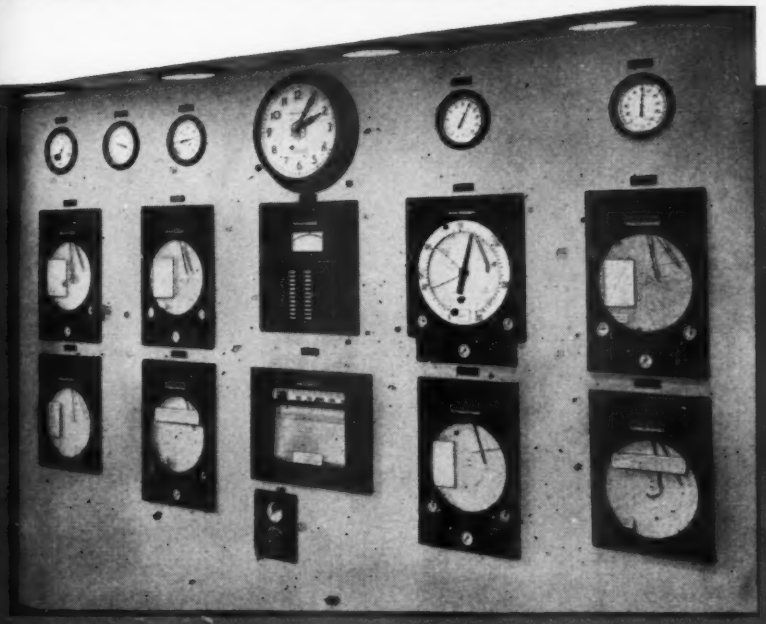


TO DEETHANIZING OPERATIONS



* BROWN INSTRUMENTATION

. . . is patterned to the exact requirements of individual plants and processes.

. . . is the result of engineering and application know-how, with one responsibility from sensing elements to control valves.

. . . is backed by a nation-wide field engineering and service organization.

BROWN INSTRUMENTS AND CONTROLS

A NEW deethanizing unit at Marcus Hook, Pa. indicates the determination of Sinclair Refining Company to meet the ever increasing demand for greater supplies of liquified petroleum gas in the East.

This modern unit . . . designed and constructed by Sinclair . . . has achieved a new high in operating ease, through modern instrumentation.

Brown Instruments on a factory pre-wired and pre-piped panelboard automatically record and control temperature and pressure in the deethanizing fractionator. In addition, reflux rate and rate of flow of charge and bottoms streams are precisely regulated . . . as is the heat input to the reboiler.

When looking for automatic recording and controlling instruments for your deethanizing operation, or *any refining operation—consider first:*

- * *The Brown know-how developed through many years of application experience in the industry.*
- * *The completeness of the Brown modern approach — recorders, controllers, panelboards, valves and all accessories.*

Call in our local engineer for a detailed discussion of your process requirements . . . he is as near as your phone. Offices in more than 80 principal cities of the United States, Canada and throughout the world. MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4488 Wayne Ave., Philadelphia 44, Pa.

MINNEAPOLIS **Honeywell**

BROWN INSTRUMENTS

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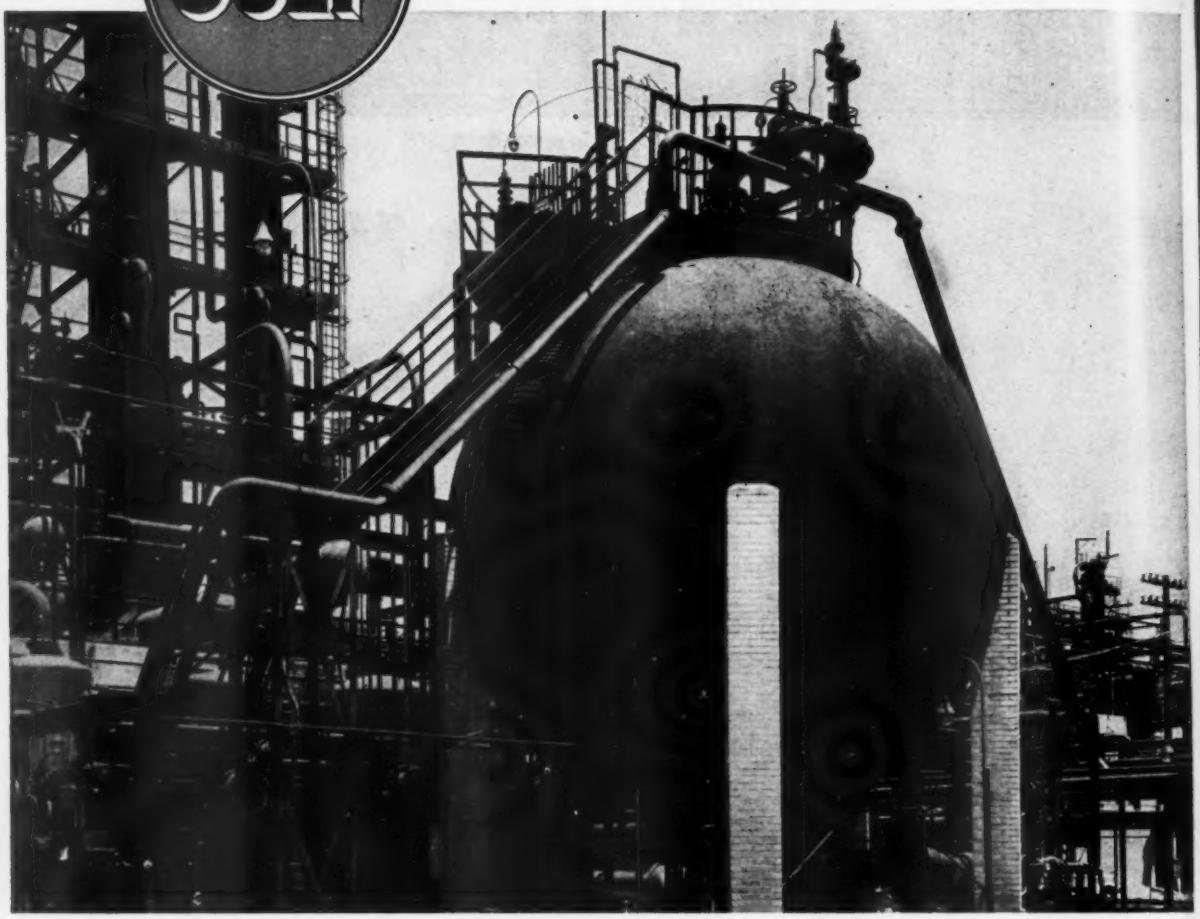
GULF

another leading refiner who desalts with PETRECO



The Petreco Electrosphere Desalter illustrated above is one of eight separate Petreco installations in the Gulf Oil Corporation refinery at Port Arthur, Texas. Gulf also uses Petreco Desalters in its refineries at Philadelphia and Pittsburgh, Pennsylvania, Toledo, Ohio, and at Fort Worth and Sweetwater, Texas. These repeated installations by a refiner with Gulf's acknowledged leadership and refining know-how speak for themselves. If you want the best in desalting equipment, engineering, service and performance—specify PETRECO. Assure your refinery of more economical operations with

Minimum Residual Salts and Solids
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PETRECO OFFERS COMPLETE DESALTING SERVICE AND FACILITIES

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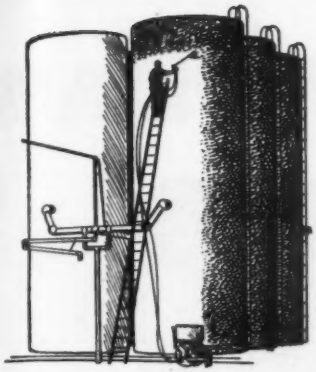
PETRECO

SPECIALIZED *Electric* PETROLEUM PROCESSES { DESALTING / DEHYDRATING

PR 51-1

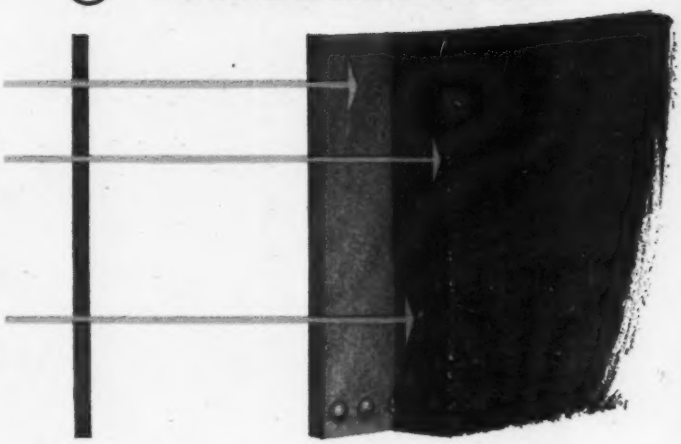


one coat of **Insul-Mastic** type "D"

prevents

- **corrosion**
- **heat loss**
- **condensation**

- **Surface to be coated and insulated.**
- **Insul-Mastic Coating, with its high Gilsonite content, prevents corrosion by stopping moisture, acids, alkalis and salts from contacting the surface under the coating.**
- **Granulated cork, in large amounts, insulates the vessel. Up to 65% of heat loss can be prevented or condensation can be controlled with a ¼" application.**



Insul-Mastic Type D insulation requires no vaporseal or further protection. It will not absorb moisture and thus will retain full insulating efficiency throughout its life. As an insulation, it has a K factor of .36 which is approximate to that of cork board. Insul-Mastic Type D is spray applied and will adhere at any angle without mechanical support. Type D can be used on surfaces having a temperature range from minus 40° F., to plus 300° F., without deterioration.

Insul-Mastic Type D has been used to prevent heat loss on oil storage tanks, paper pulp digesters, liquid sugar tanks, warm air ducts, prefabricated metal buildings and many other types of equipment, piping, etc. It controls condensation on cold water intake pipes for boilers, in railroad freight cars, on building panels, corrugated metal roofs, and cold air ducts, etc.

Write for our booklet, "INSUL-MASTIC TYPE D INSULATION" and for the name of your nearest Insul-Mastic representative.

Think first of the coatings that last!

Insul-Mastic Corporation
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1158 OLIVER BUILDING · PITTSBURGH 22, PA.
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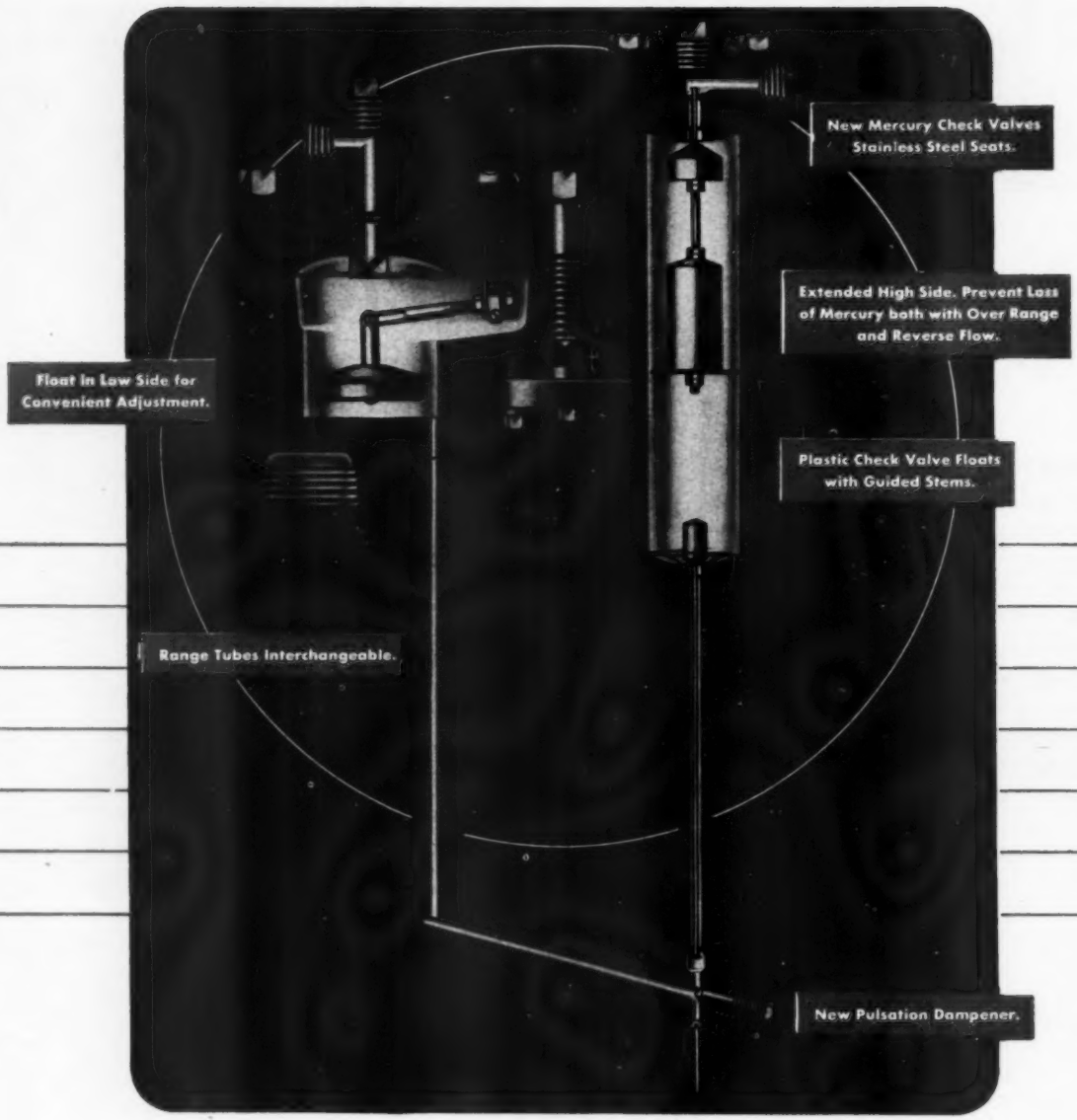
accurate • sensitive


New Mercury Check Valves Stainless Steel Seats.
Extended High Side. Prevent Loss of Mercury bath with Over Range and Reverse Flow.
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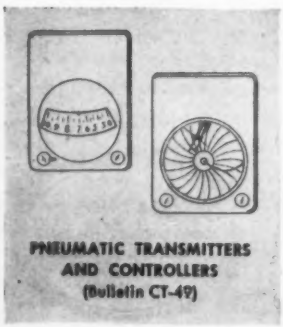
Plastic Check Valve Floats with Guided Stems.
Range Tubes Interchangeable.
New Pulsation Dampener.



PNEUMATIC TRANSMITTERS AND CONTROLLERS
(Bulletin CT-49)

HIGH PRESSURE IRONCASE DISPLACEMENT METERS
(Bulletin 50-A)

FLANGES
(Bulletin EG-2)

ORIFICES
(Bulletin EG-2)

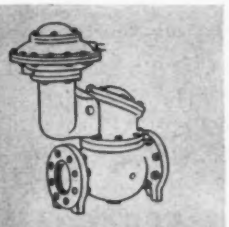
and built for 5000# w.p.

In response to insistent demands from gas and oil production men, the Model A-88 5000# American-Westcott Orifice Meter has been developed for high pressure services.

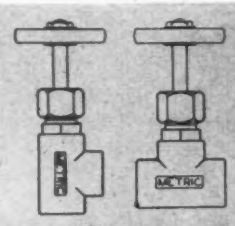
Designed in every way to operate safely and accurately under these pressures, the Model A-88 5000# Orifice Meter provides every feature that has made American-Westcott Orifice Meters outstanding for accuracy, simplicity and low maintenance cost. Its new design incorporates the proven features of the American-Westcott Orifice Meter and the many recent improvements in the A-88 Series to provide an accurate, rugged meter for today's higher operating pressures.

1. **Available in 50" and 100" ranges.**
2. **Low-side body constructed of forged steel of high tensile strength — high-side body made of extra heavy seamless steel.**
3. **Hydrostatically tested to 10,000 psi.**
4. **Adjustments easily made without disturbing working parts.**
5. **All parts can be handled and adjusted by small standard tools.**
6. **Every part accessible for cleaning without removing or loosening any connections that affect accuracy.**
7. **High sides interchangeable without affecting gage line connections.**

These and other American-Westcott features provide simple, accurate, dependable orifice meters that will handle the toughest kinds of measurement problems under the most rugged field conditions, with a minimum of servicing. They maintain to the highest degree the century old American Meter Company tradition of "sustained accuracy at lower cost." Write for descriptive matter.



PILOT LOADED, LARGE CAPACITY CBV REGULATOR (Bulletin 50)



NEEDLE VALVES, SCREWED AND UNION BONNET (Specification Sheet)

AMERICAN METER COMPANY

INCORPORATED (ESTABLISHED 1836)

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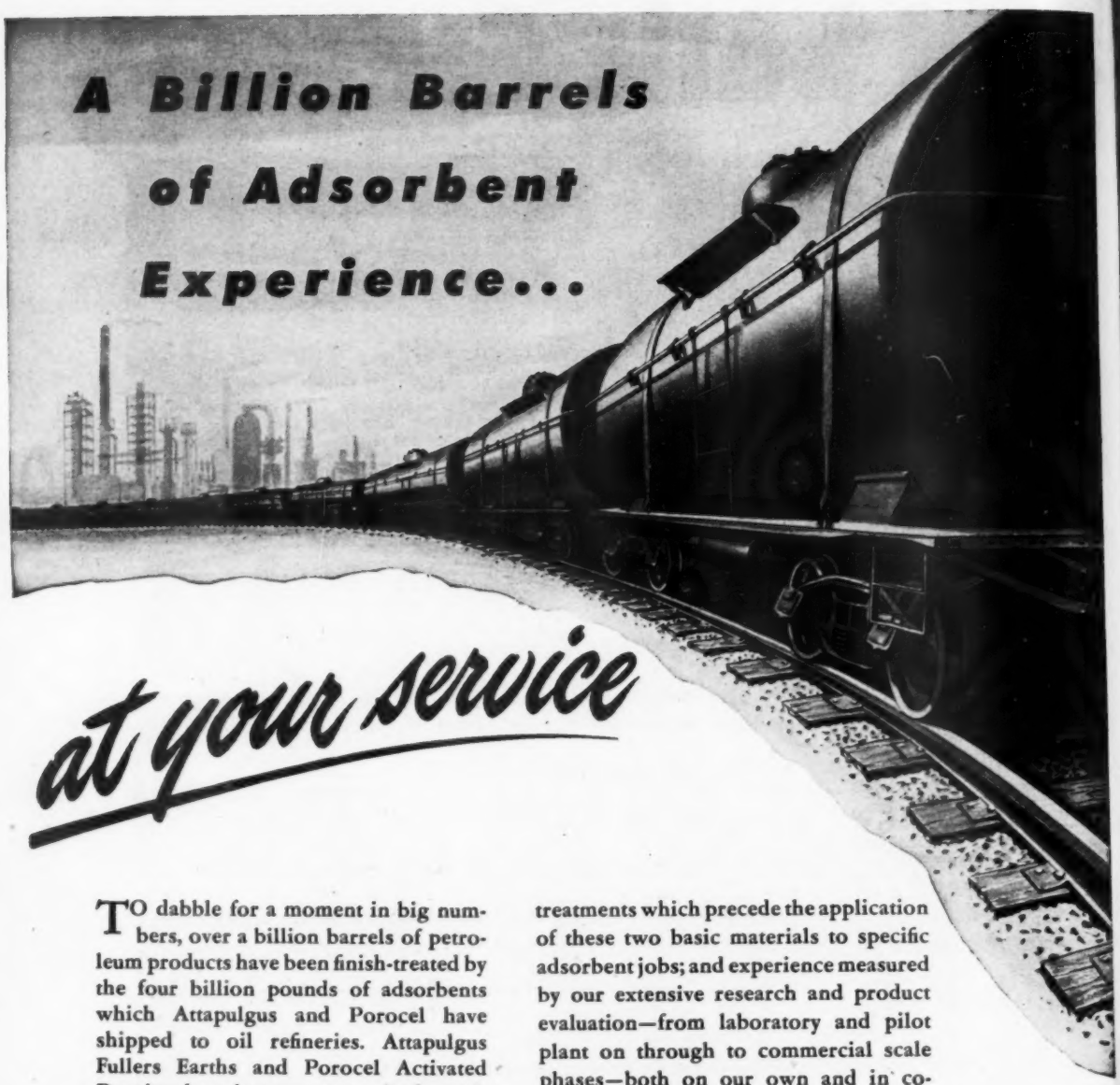


at your service

TO dabble for a moment in big numbers, over a billion barrels of petroleum products have been finish-treated by the four billion pounds of adsorbents which Attapulgus and Porocel have shipped to oil refineries. Attapulgus Fullers Earths and Porocel Activated Bauxites have become recognized standards in the removal or reduction of odors, colors, tastes, moisture, acids, sulfur, fluorides and unsaturates, and for solid catalyst purposes. And in this wide range of services, remarkable finished value was gained in a long list of petroleum cuts—from the lightest distillates to the heaviest lubes and waxes.

This all adds up to a lot of adsorbent experience—experience with the many treatments which precede the application of these two basic materials to specific adsorbent jobs; and experience measured by our extensive research and product evaluation—from laboratory and pilot plant on through to commercial scale phases—both on our own and in cooperation with our customers.

So there's great merit to the suggestion that it pays to consult Attapulgus and Porocel. In your own plans to improve products or expand output, perhaps our one billion barrels of adsorbent experience can be of real help to you in selecting the right adsorbent and the right conditions. Our laboratory and process staff are at your service, without obligation.

ATTAPULGUS CLAY COMPANY *Fullers Earth* · **POROCEL CORPORATION** *Activated Bauxites*

Dept. V, 210 West Washington Square, Philadelphia 5, Pa.

Macks ARE Masters
OF THE TOUGHEST TERRAIN

No matter how tough the going... under the worst of weather conditions... through slippery mire or shifting sand... or over rutted, uneven ground – big SUPER MACK trucks keep the payloads moving on time... at less cost and with less absenteeism.

One big reason why Mack trucks lick the toughest terrain is the exclusive Mack inter-axle Power Divider*. Where unequal tractive requirements are encountered, the Power Divider, acting as a third differential, distributes torque to favor the axle and wheels having the most traction, thus eliminating power dissipation in useless wheel slippage.

Mack's exclusive Power Divider combines with numerous other outstanding Mack features to give you the power, strength, traction and easy maintenance so necessary for dependable, uninterrupted service on the job. Your nearest Mack branch or distributor will give you complete details. You'll find it's a story worth listening to.

*On Mack six-wheelers

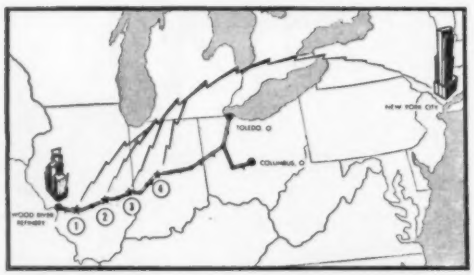
Mack Model LJ six-wheeler, equipped with mobile telescoping mast. Used by Asiatic Petroleum Corporation in overseas operations.

Mack TRUCKS ... outlast them all

Mack Trucks, Empire State Bldg., New York 1, New York. Factories at Allentown, Pa.; Plainfield, N. J.; Long Island City, N. Y. Factory branches and distributors in all principal cities for service and parts. In Canada: Mack Trucks of Canada, Ltd.

With no station operator needed, G-E switchgear (right)—containing main motor starters, relays, and meters to indicate pressure and load—activates station pumping operations in proper sequence on teletyped signals from central dispatcher (top left).

AUTOMATIC pumping-station operation!



From almost halfway across the country, central dispatcher in New York's Radio City controls flow of 22 different products through 4 new booster stations in Illinois and Indiana. Thanks to the combined efforts of Shell, A.T. & T., and G-E engineers, line capacity is now up by 168,000 gallons a day, with man-hour needs kept to a minimum.

G-E engineering and equipment in 4 new remotely-controlled Shell stations help boost line capacity, cut man-hour costs

A central dispatcher in New York dials some code numbers. Hundreds of miles away—in one of four new booster pumping stations on Shell Oil Co.'s East Products Pipeline—General Electric switchgear, control, and accessory equipment goes into action. In proper sequence, motorized valves are opened and closed, pump motors started and stopped, operating reports sent, or the station's single maintenance attendant summoned for an emergency—all automatically!

G-E engineering and equipment—which played a major part in this first application of long-distance automatic remote control to pipeline stations—can help electrify *your* pipeline as well for higher throughput, lower costs. Your G-E representative will gladly show you how. *Apparatus Dept., General Electric Co., Schenectady 5, N. Y.*

Everything you need to cut oil pipeline costs —ELECTRICALLY!

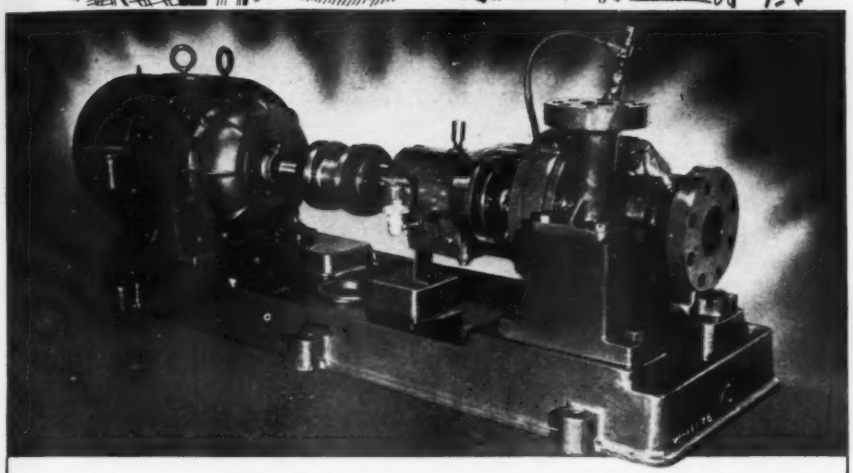
GENERAL ELECTRIC

661-24

They ALL Go For

THE TYPE HM!

Worthington's New Process Pump a Hit With Refinery Men, From Operators to Management



A TRULY VERSATILE PROCESS PUMP! The Worthington Type HM Centrifugal is available with conventional packed box or mechanical seal, in capacities up to 650 gpm, heads up to 475 ft. and in a wide choice of materials — cast iron, bronze, stainless steel, carbon steel and Worthite.

Seldom has any pump received so hearty a welcome at all levels of refinery organization as Worthington's Type HM

Operators like its ruggedness and thorough dependability

Storekeepers find its maximum interchangeability of parts saves time

Maintenance men praise its quick adaptability to either a packed stuffing box or mechanical seal, its spacer type coupling that allows removal of the rotor assembly without disturbing piping or driver, and its over-all simplicity of construction that assures such easy inspection and repair

Engineers and power plant men are impressed by its correct hydraulic and mechanical design, low NPSH and power requirements, and sustained high efficiency

Management realizes that the long life, low cost upkeep and versatility of the Type HM mean a first class capital investment for present and future process pumping

GET ALL THE FACTS

Contact our nearest District Office or write direct for Bulletin W-341-B14 Learn why the Type HM is still further proof that *there's more worth in Worthington*

Worthington Pump and Machinery Corporation, Centrifugal Pump Div., Harrison, New Jersey

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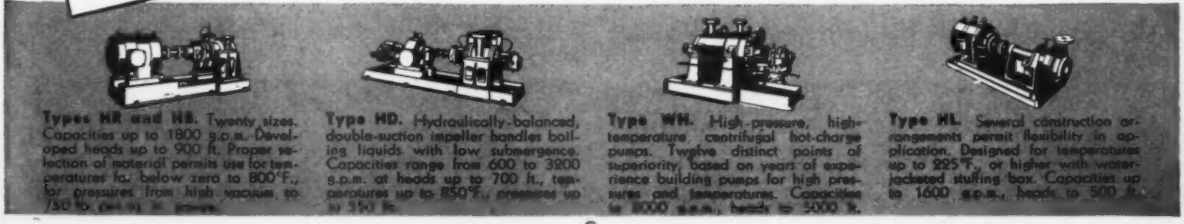
MEMBER

THE WORLD'S BROADEST LINE ASSURES YOU THE RIGHT PUMP FOR EVERY JOB

WORTHINGTON

CO-3



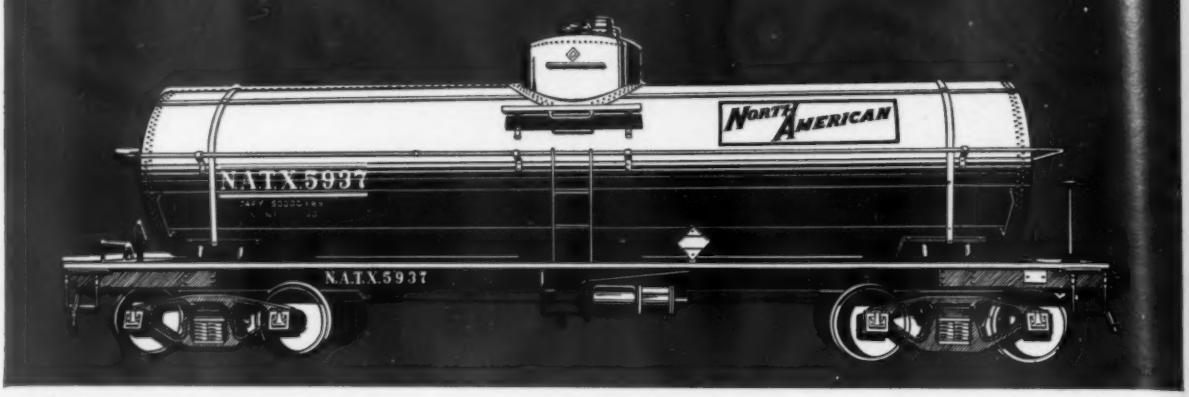
Types HR and HS. Twenty sizes. Capacities up to 1800 g.p.m. Developed heads up to 900 ft. Proper selection of material permits use for temperatures to below zero to 800°F., for pressures from high vacuum to 750 lb. gage.

Type HD. Hydraulically-balanced, double-suction impeller handles boiling liquids with low submergence. Capacities range from 600 to 3900 g.p.m. at heads up to 700 ft., temperatures up to 850°F., pressures up to 350 lb.

Type WH. High-pressure, high-temperature centrifugal hot-charge pumps. Twelve distinct points of superiority, based on years of experience building pumps for high pressures and temperatures. Capacities to 1000 g.p.m., heads to 5000 ft.

Type HL. Several construction arrangements permit flexibility in application. Designed for temperatures up to 225°F., or higher with water-jacketed stuffing box. Capacities up to 1600 g.p.m., heads to 500 ft.

Helping Petroleum Shippers



A NORTH AMERICAN SPECIALTY for 43 straight years!

North American Car Corporation served its first petroleum shipper back in 1908... started a specialized shipping service that today keeps petroleum products moving safely and economically to markets from coast to coast. Currently *over half* of North American's great tank car fleet serves the big petroleum industry *exclusively.*

Let a North American traffic expert help solve *your* individual shipping problems. Remember, he's thoroughly grounded in the efficient movement of petroleum products — a North American specialty for 43 straight years! And he's got reliable, up-to-the-minute shipping information that will save you time and money.

Help yourself to this storehouse of transportation knowledge. It's specialized, it's extensive...and it's yours for added safety, dependability and economy. Call or visit the North American office nearest you. Do it today — *without obligation.*

For Special Products Requiring Special Care

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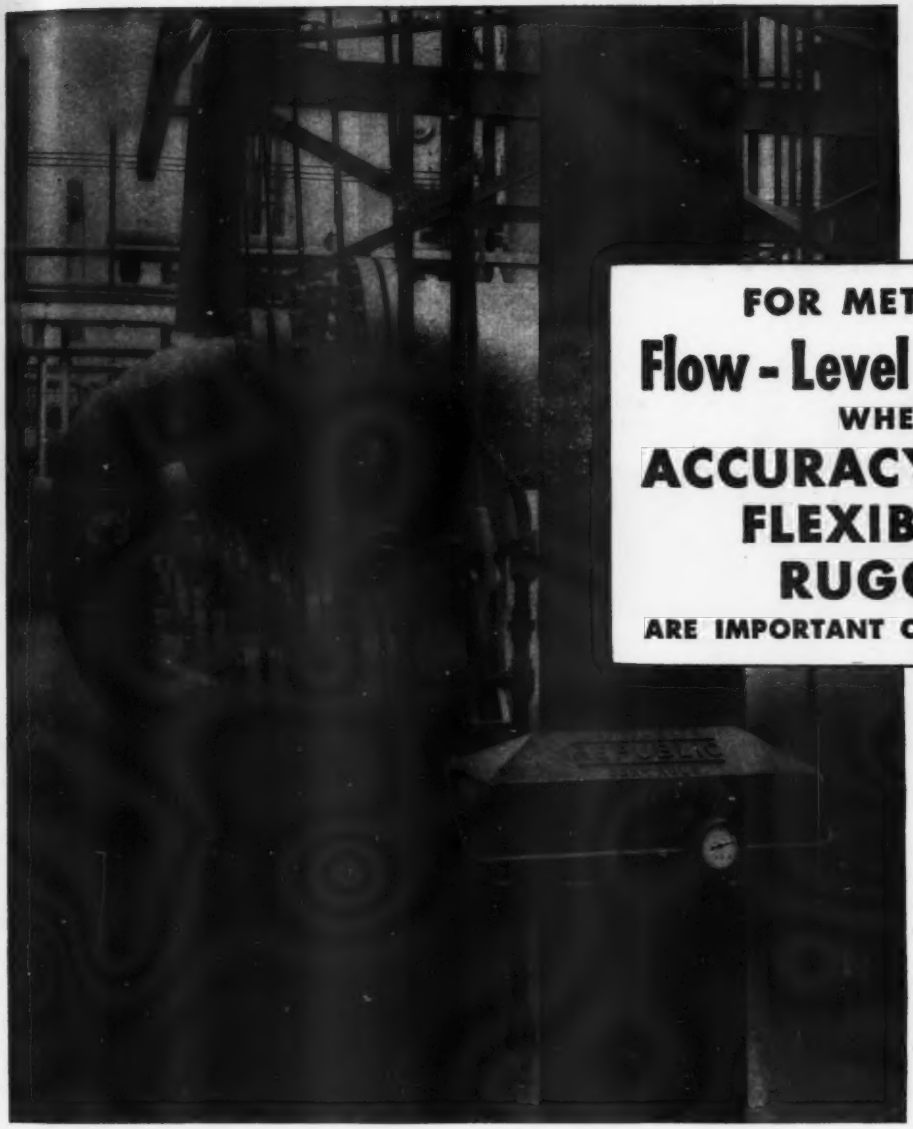


FOR METERING

Flow - Level - Pressure

WHERE

ACCURACY
FLEXIBILITY
RUGGEDNESS

ARE IMPORTANT CONSIDERATIONS

One of a group of Republic transmitters metering flow and level in a modern chemical processing plant.

Republic Pneumatic Transmitters are available for measuring flow, liquid level, pressure or liquid density of a wide range of fluids. They employ the force-balance principle to convert these process variables into air pressures which vary proportionally. These air pressures become direct measurements and can be conducted to reading instruments or used as the measuring impulse for the actuation of an automatic controller.

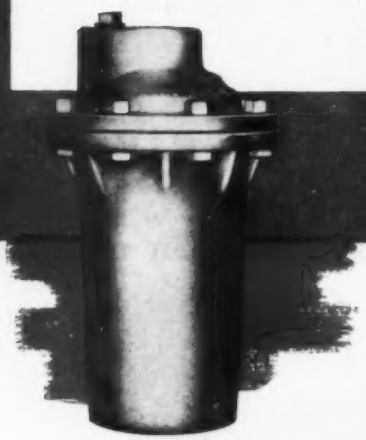
Republic transmitters have a guaranteed accuracy of within 1/2 of 1% of the transmitter range. By making a few minor adjustments or substituting a few small parts, their operation can be easily changed to any desired range between a minimum of 0-0.6" to a maximum of 0-704" of water. Their construction is more like that of a precision machine than of the sensitive instrument they are. Data Book No. 1001 contains complete details — write for your copy.

REPUBLIC FLOW METERS CO.

2240 Diversey Parkway, Chicago 47, Illinois

NO STEAM LOSS
FROM ZERO TO FULL LOAD

ARMSTRONG TRAPS
DON'T PASS STEAM



UNLIKE some devices, Armstrong traps will not pass steam, regardless of load conditions. The diagrams at the right show this conclusively. Under no-load conditions here is what happens: steam in the bucket eventually condenses due to radiation loss. When enough condensate is formed in this manner to cause the bucket to lose buoyancy and sink, the trap empties itself and the cycle repeats. The radiation loss is small—as it would be in any device of similar size. There is no steam loss!

When there is a condensation load, the operation is the same except that the trap remains open until all condensate flowing into it is discharged.

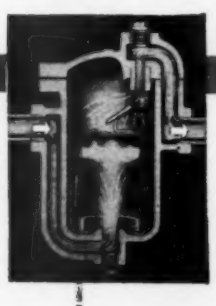
Freedom from steam loss saves fuel, keeps down back pressure in return lines. Call your nearby Armstrong Representative for the traps you need now.

ARMSTRONG MACHINE WORKS

868 Maple Street • Three Rivers, Michigan

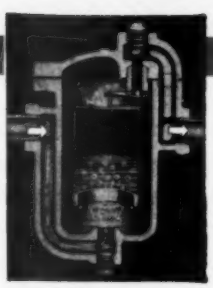
OPEN

When accumulated water causes bucket to lose buoyancy, trap opens wide.



CLOSED

After condensate is discharged, steam entering bucket causes it to float, closing the valve tight. Valve remains closed until steam condenses.



SEND FOR THE 36-PAGE STEAM TRAP BOOK. It tells you how to do the best possible trapping job with facts, figures and diagrams.

SEE OUR CATALOG IN SWEET'S or CEC

ARMSTRONG STEAM TRAPS

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SERVICE LEDGER
1901-1951

ANGLO-IRANIAN OIL CO. LTD.
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ATLANTIC REFINING CO.
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SOCIETE GENERALE DES HUILES DE PETROLE
SOCIETE INDUSTRIELLE BELGE DES PETROLES
SOCONY-VACUUM FRANCAISE
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WASATCH OIL CO.
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Westward Across Canada... with B-A!

Through its Canadian affiliate, Kellogg undertook for The British American Oil Company, Ltd., in 1947 . . . a major modernization of B-A's Montreal East Refinery, aimed at increasing throughput by 100% and raising the quality of the final product.

The first combination topping and decarbonizing unit and the first integrated Fluid catalytic cracker and cat poly unit were designed for this project.

At about the same time, Canadian Kellogg moved further west to design and construct a deasphalting unit for B-A's Clarkson Refinery.

And now, on the approaches to Canada's great, new western oil fields, Canadian Kellogg is constructing—at Edmonton, Alberta—a complete new refinery including Fluid catalytic cracking for this outstanding Canadian refiner.

THE M. W. KELLOGG COMPANY

A SUBSIDIARY OF PULLMAN INCORPORATED

for fifty years an integral part of processing history

NEW YORK JERSEY CITY LOS ANGELES TULSA HOUSTON TORONTO LONDON PARIS

XUM

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Portrait at

This year is Kellogg's fiftieth of service to industry. At this time naturally, as a group of men—known collectively to the modern business world as The M. W. Kellogg Company—we can think back nostalgically. We can remember the chimney stacks

"Ally of Process Development"

The first of these camera "portraits" of M. W. Kellogg today, which appeared last month in this publication, pointed up the completeness of the Kellogg organization working in the laboratory phases of applied chemical research and process development.

This month, some aspects of Kellogg's completely integrated Metallurgical Engineering Division are high-lighted to indicate the vital role they play in the advancement of processing, engineering and fabrication.

1. *PARALLELING KELLOGG'S* growth in the processing phase of oil refining has been its contribution to metal fabrication—a contribution based on early and continuing metallurgical research. As processing conditions have become continuously more severe and more exacting, this research has resulted in the creation of new, more precise specifications for materials . . . new methods of fabricating . . . and new methods of testing.

4. *PHOTOMICROGRAPHY, TOO,* plays an important part in Kellogg's metals research. It has proved particularly helpful to the company in its improvement of welding techniques both for shop and field fabrication. Demand for such metallurgical developments has so increased in the last decade that the original metallurgical laboratory has been expanded into a complete Metallurgical Engineering Division.

5. *X-RAY DIFFRACTION* serves continuously in Kellogg's investigation of metals for process applications—investigations conducted to develop metals for service at temperatures from about −300°F. to 5,000° F., and pressures up to 3000 pounds per square inch, and in the presence of such virulent corrosives as hydrofluoric and nitric acids.

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Fifty... no 2

KELLOGG
1901-1951
50th Anniversary

we built in 1901 . . . the first crude vessels for oil refiners in the 'teens . . . our first combination unit . . . the forty-odd Fluid cat crackers built in these years. But, after all, The M. W. Kellogg Company is only a factor as it is able to serve industry today. For that reason, we are presenting this series of monthly camera studies which document our belief that a truly integrated organization can better serve industry to achieve greater earning power. This is No. 2 in the series.

VESSELS, PIPING and other metal equipment are, of course, the backbone of the refining industry. Moreover, high-temperature, high-pressure piping installations for utility power stations comprise the company's second largest sales operation. To meet the technical demands of this business, the characteristics of metals under a wide variety of conditions must be studied continuously, with modern test equipment.

3. ***KELLOGG TODAY OPERATES*** one of the most complete creep laboratories in the country, to study metals under all manner of temperature and load conditions. This biaxial test unit—believed to be the only one of its kind—exerts a two-directional stress at high temperature. In operation, tubular metal specimens are pulled apart at the same time as internal gas pressure seeks to burst them circumferentially.

6. ***THIS INTERESTING TOOL,*** termed a weld prober, was pioneered by the company's metallurgists for the study of ***graphitization*** in piping. This unusual metal "disease" was originally discovered in power piping operating under continuous high temperatures and pressures. The weld prober contributes significantly to the study, by permitting the removal of samples of welds and piping while the pipe remains in service position.

7. ***MAGNETIC,*** fluorescent dye and ultrasonic techniques—all non-destructive test methods—are also employed to explore the characteristics of metals before and after service under varying operating conditions. Guiding this continuing research into metal behaviour is a group of engineers and scientists who are internationally famous in their specialties, leaders on industry code committees, and members of key technical Defense groups.

NEXT MONTH

. . . in the third in this series of camera studies of M. W. Kellogg today . . . you will glimpse a few of the many development projects which utilize the results of these metallurgical studies.

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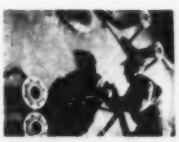
M. W. KELLOGG

Large and small vessels for handling unusual corrosives . . . extremes in high and low temperature operations . . . high vacuum to high pressure—these are the vessels that refiners time after time "earmark" for Kellogg, because Kellogg-fabricated vessels measure up when the going is tough.

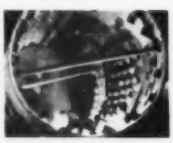
Pressure Vessels
Vacuum Vessels
Fractionating Columns
Drums and Shells
Heat Exchangers
Process Piping
Hi-pressure—Hi-temp Power Piping
Bends and Headers
Giant One-Piece Bends
Forged and Welded Fittings
Radial Brick Chimneys

Continuing Study of behavior of metals under stress at high temperatures has produced valuable design data.

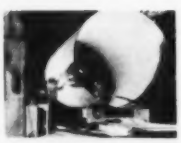


Shop Layout Craftsmen are fully experienced in vessel fabrication from nozzle positioning to "knockdown" fabrication for field assembly.

Extensive Facilities from bending of plate to final machining of precision surfaces permit complete fabrication under the same roof.



Special Welding Techniques and stress relieving methods assure equipment performance even under severest operating conditions.



Rigid Quality Control through non-destructive inspection, maintained by inspectors reporting directly to management.

NEWS FOR OPERATORS IN WESTERN CANADA

The Canadian Kellogg Company Ltd. has established complete shop facilities for the fabrication of all types of piping at **EDMONTON**, Alberta. Inquire directly or through any Kellogg or Canadian Kellogg office.

The M. W. Kellogg Company *(A Subsidiary of Pullman Incorporated)* New York, Jersey City, Los Angeles, Tulsa, Houston, Toronto, London, P

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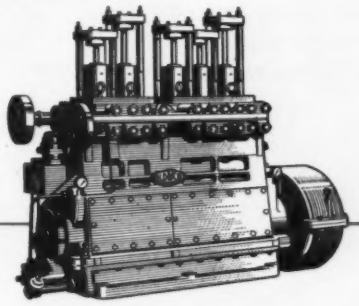
It's the short way home . . . when the high road means a straight line and a through-flow of traffic. It means too that you can get more work done today . . . and still more tomorrow.

Designed to give virtually the same results, the Aldrich Direct Flow Pump passes liquid *directly* through the working barrel. Aldrich design engineers have successfully eliminated two right angle turns in the fluid-end block.

This design, resulting in a reduction of "loss space", means more work done at less cost. Volumetric efficiency is improved and materials are saved. In each size, you get a smaller pump that does the same work better . . . which is why more people are coming to Aldrich for pumps made in 3", 5", 6" triplex; 5", 6" quintuplex and 5", 6" septuplex units . . . to meet medium-to-high pressure and capacity requirements.

Applications where Aldrich Direct Flow Pumps are operating today include: water flooding, salt water disposal, lean oil to absorbers, and the handling of diethylene glycol, gasoline, propane, butane. Request Data Sheets 64 and 64B for complete information.



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Use Raybestos-Manhattan packings and gaskets for the valves in your plant, whether they're for oil, water, steam, sewage, chemicals, or any other gas or fluid. R/M manufactures a complete line of packings not only for valves, but for practically every type of industrial equipment. Your R/M distributor will be glad to help you select the right packing. Or write for the new R/M packing catalog today.

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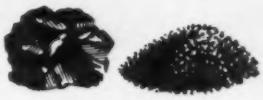
Bingham

PRECISION BUILT FIELD PROVEN PUMPS

Koke-Krusher

...the only pump that crushes entrained coke

This centrifugal pump does what heretofore has been considered impossible — it instantly pulverizes large pieces of coke in the pumpage by crushing. A durable, positive crushing mechanism located in the suction chamber in front of the impeller eye instantly crushes large pieces of hard coke entrained with the pumpage and pulverizes them before they can enter and clog the impeller and system equipment.



CRUSHES INSTANTLY

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An important factor in Bingham precision built pumps is the static and dynamic balancing of all impellers and rotating parts by means of Gisholt Dynetric balancing equipment shown (right). This is typical of the precision machinery in our new and modern plant.

Battery of Bingham Koke-Krusher Pumps handling black oil (flash tower) at ESSO Standard Oil Company's Bayway Refinery, Linden, N. J.

Gisholt Dynetric Balancer in our new and modern plant.

SEND NOW

For Exhibit Box

Contains sample of hard coke before and after entering Koke-Krusher. Also Bulletin 106 giving 12 reasons why it is sound economy to use the Koke-Krusher in new and to replace old installations.

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DOUBLE VOLUTE RADIAL BALANCE

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Facts you should know about De Laval turbines!

This turbine has two traffic cops...

that give you double protection against overspeeding. The normal speed governor and overspeed governor are entirely separate. A sticky governor valve can't possibly jeopardize the operation of the overspeed governor and trip.

You can elect the governor that meets your requirements!

We have eight candidates for the job, so take your choice:

Mechanical Shaft governor with smooth-acting, long-wearing "rocking chair" action.

Vertical Mechanical governor geared to shaft for speeds above 4500 rpm.

Hydraulic Governor. Direct acting orifice-type for high speeds and/or wide range of speed adjustment.

Hydraulic Oil Relay for close regulation or for supplying extra power for valve movement.

Flyweight Oil Relay for close regulation such as encountered in synchronous generator drives.

Pressure Controls for constant pressure or differential pressure regulation of pumps, blowers, etc.

Speed Changers, manual or remote control by electric motor drive.

Auxiliary Trips to shut off steam in the event of low pressure in the lubrication system or undue rise of back pressure. Also can be solenoid operated for remote or manual trip, or for inter-connection with the driven machine or any emergency system.

Send for Catalog 82-19R

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TURBINES • HELICAL GEARS • CENTRIFUGAL BLOWERS AND COMPRESSORS
CENTRIFUGAL PUMPS • WORM GEAR SPEED REDUCERS • IMO OIL PUMPS

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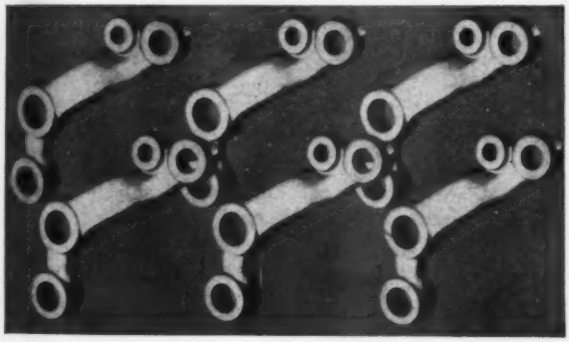
3 ways TIMKEN® steels help you make better forgings —at lower cost!

1 HIGH QUALITY! The superior surface and internal quality of Timken® forging steels, plus their uniform forgeability, gives you better finished forgings—with fewer rejects, delays and shop-practice changes.

2 TAILOR-MADE! Using advanced melting and finishing techniques, Timken makes certain that chemical and physical properties will meet your specifications exactly.



3 UNIFORM! From bar to bar and from heat to heat, Timken forging steels give you uniform composition, uniform forgeability and uniform response to heat treatment. That's assured by Timken's rigid control and inspection methods.

For better forgings at lower cost, get the recommendations of our Technical Staff. And for a complete catalogue of our steels, "Timken Steel Products", write on your letterhead to The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".

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Specialists in alloy steel—including hot rolled and cold finished alloy steel bars—a complete range of stainless, graphitic and standard tool analyses—and alloy and stainless seamless steel tubing.

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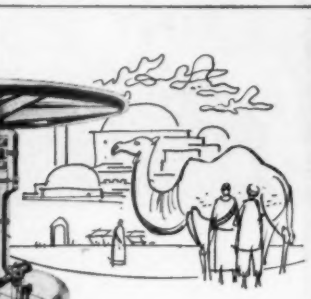

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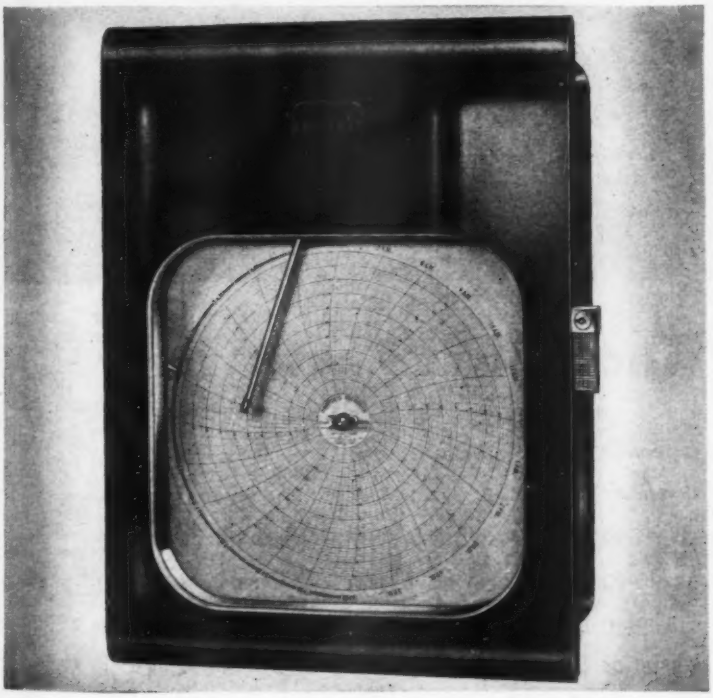
The heart of the pressure gauge is the pressure measuring element.

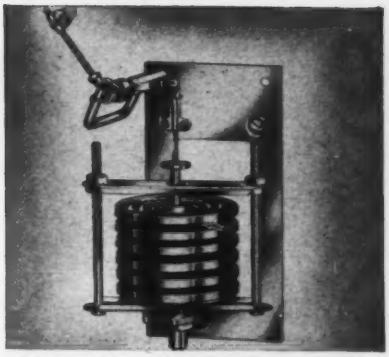
Hundreds of thousands of Bristol recording gauges in use all over the world, operating under all kinds of conditions, testify to the high accuracy, long life, and permanent calibration of Bristol's element.

Many Bristol gauges have been in constant service for 20, 30 and 40 years!

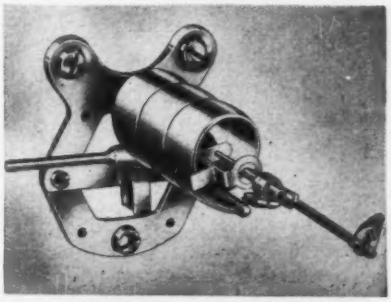
Now Bristol presents its *new* line of Series 500 recording pressure gauges in ranges from 0 to 6 millimeters mercury absolute to 0 to 10,000 psi. They have many outstanding new features which make them easier to use, convenient to service, readily convertible. And they incorporate the three most advanced designs of measuring elements.

Models are available for recording, automatic controlling, pneumatic transmission and telemetering. Immediate delivery on many ranges. Write for new 32-page Catalog G621. THE BRISTOL COMPANY, 120 Bristol Road, Waterbury 20, Conn.

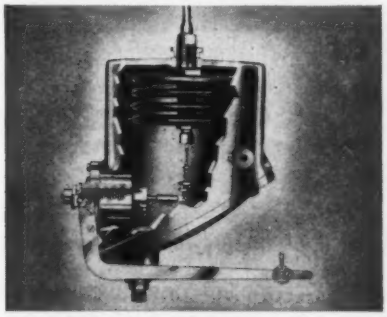




FOR LOW PRESSURE RANGES—new Type E measuring element is used for ranges from 0-2 in. water to 0-29.9 psi pressure or vacuum. Extremely high torque gives positive pen positioning across entire range. Highly accurate, extremely stable. 250% inherent over-range protection.



FOR INTERMEDIATE AND HIGH RANGES—new helical measuring element is for ranges from 0-30 psi to 0-10,000 psi. Special nonferrous alloy—heat-treated to withstand impact of rapid fluctuations—gives permanent accuracy over a long period of service life.



FOR ABSOLUTE PRESSURE—new single-bellows type element measures ranges as low as 0-6 mm. mercury absolute and gives direct reading of pressure above absolute zero inherently corrected for barometric variations—with far greater accuracy than ever before.

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AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

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In case you're not getting all the "pipe with the yearmark" you'd like to have, remember there's one customer whose needs come before yours. We at Wheatland are doing our utmost to maintain the policy of equitable distribution for all our customers—small as well as large—at all times. However, whether or not we can supply your requirements as completely now—and in the future—as we have supplied them in the past, we think you'll agree that we serve you best in serving the needs of *the nation* first.

-pipe with the yearmark!

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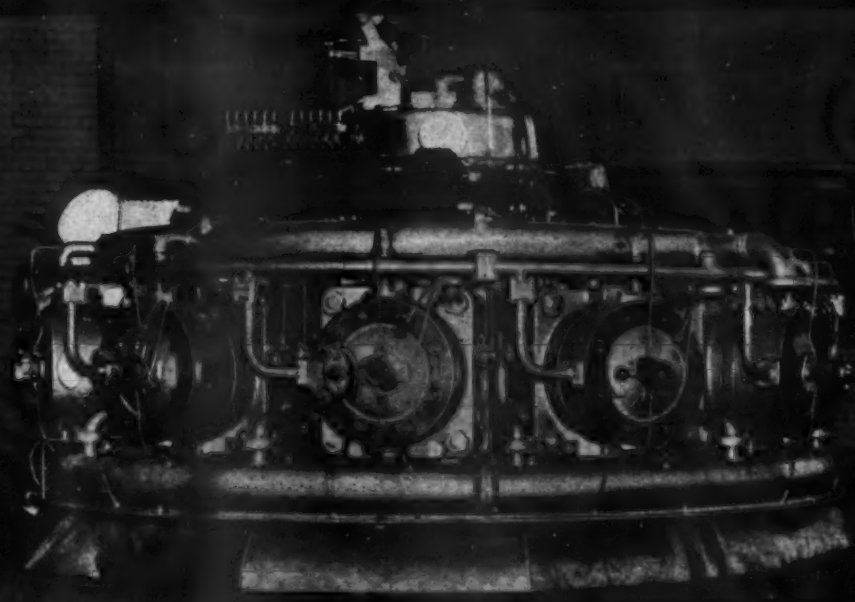

Another "FIRST" by ELLIOTT

First Commercial Radial Engine-Driven A. C. Generating Unit

Using only a fraction of the floor space required by a similar rated horizontal Diesel unit, this vertical installation is tops in compactness. The Elliott synchronous generator, rated at 1612 kva, 400 rpm, 2400 volts, has been specially designed so that the generator stator is housed within the engine base, eliminating the necessity for the stator wrapper, and conserving space. Further compactness is obtained by building extra mass into the generator rotor, eliminating the need for an engine flywheel.

Along with these features, all the flexibility and efficiency of Elliott "Fabri-Steel" design and construction have been maintained. The stator frame and rotor spider are of welded steel for strength and rigidity. The advantages of ample capacity, superior coil insulation and silver brazed electrical joints are likewise preserved.

Bulletin PB-2000-2 gives all the details. Write for a copy today.

J-722

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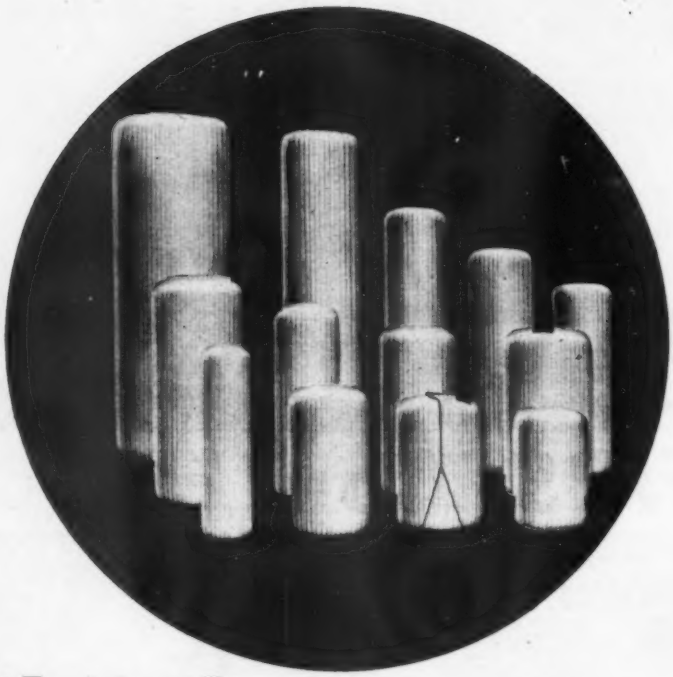

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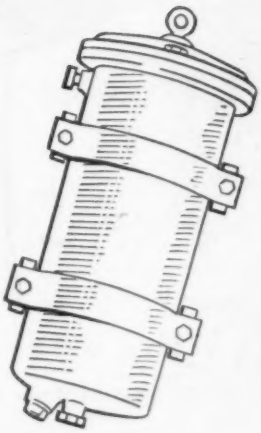
More and more, as the national emergency makes it imperative that you protect your engines against the danger of being unable to replace or repair them, your maintenance program must provide for dependable filtration of fuels and lubricants. The urgency of your need makes it doubly worth your while to remember that Winslow manufactures over 200 sizes and shapes of fine elements. There's a Winslow Element for any make or model of filter that you may own!



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*there's a WINSLOW FILTER for any ENGINE

WINSLOW FILTERS

W-512

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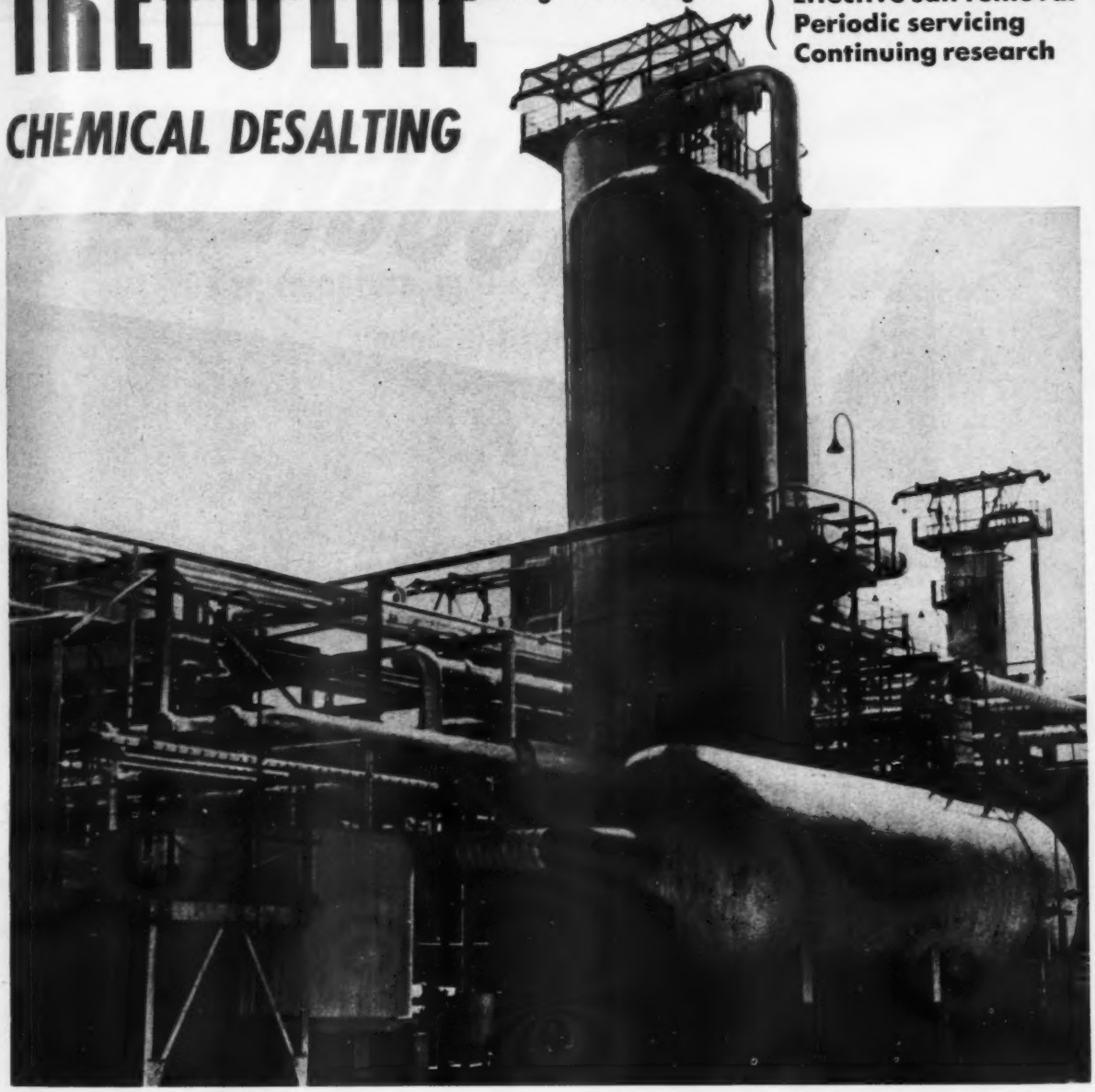
CHEMICAL DESALTING

Ensures these money-saving advantages

- Low installation costs
- Low operating costs
- Effective salt removal
- Periodic servicing
- Continuing research



HIGH EFFICIENCY

LOW COST

In many of America's leading refineries Tretolite desalting is delivering salt removals as high as 90 to 95%. The low water requirement seldom exceeds 5 to 8% of the total volume of the crude charge. Tretolite desalters now in use range in capacity from 2,000 to 50,000 barrels per day per plant, since Tretolite desalting is adaptable to either large or small refining operations. Periodic checking by Tretolite desalting engineers insures that your Tretolite desalting process stays at top operating efficiency.

The recognized economy of Tretolite desalting is due to the high flexibility of the process. This process flexibility often permits the use of existing refinery equipment as part of the desalting installation, obviously holding installation costs at a minimum. This low installation cost, plus the low water, heat and chemical requirements, helps to hold Tretolite desalting cost per barrel at a minimum.

TRETOLITE COMPANY *Chemicals for the Petroleum Industry*

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DESALTING • DEHYDRATING • WATER DE-OILING • CORROSION INHIBITION • SCALE PREVENTION

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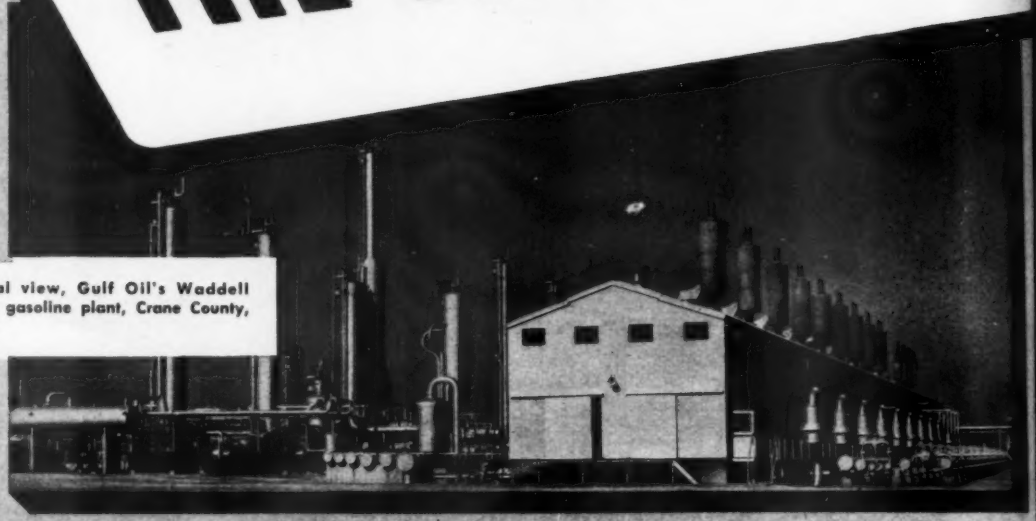
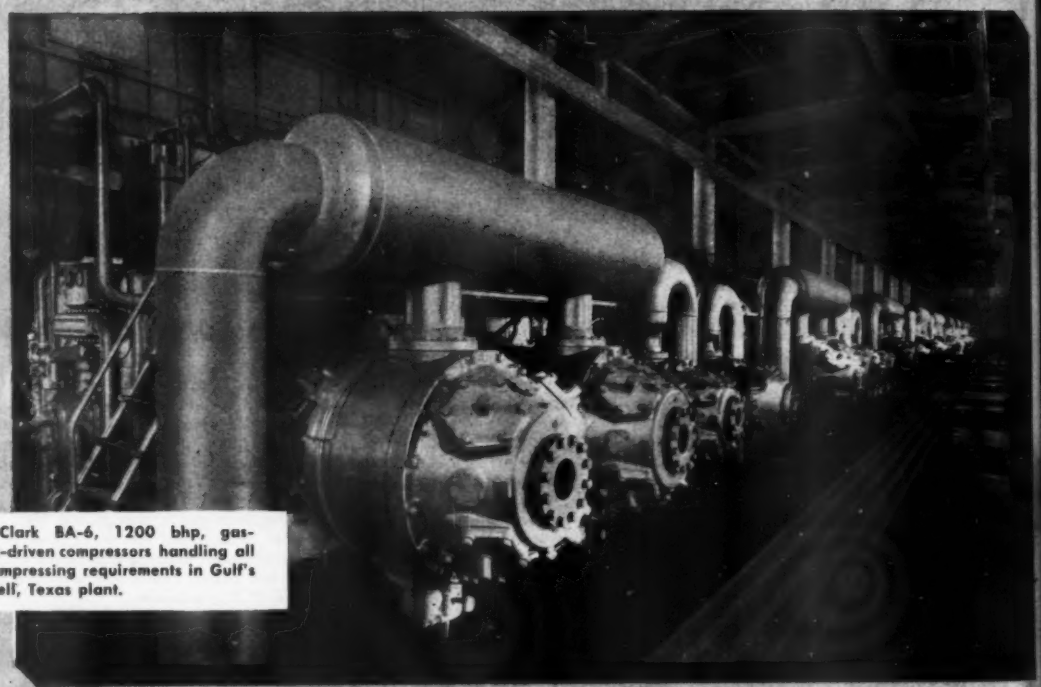
THE TOUGH ONES.



General view, Gulf Oil's Waddell natural gasoline plant, Crane County, Texas.



Nine Clark BA-6, 1200 bhp, gas-engine-driven compressors handling all gas compressing requirements in Gulf's Waddell, Texas plant.

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...Invariably GO TO CLARK!

For compressing 40,000,000 cu. ft. of gas per day under difficult conditions at Gulf Oil's Waddell, Texas plant, Clark Compressors were given the job

Compressing 40,000,000 cu. ft. of raw gas per day from 20 psig. suction to 600 psig. discharge pressure is a man-sized assignment under *any* circumstances. But, at Gulf Oil Corporation's Waddell gasoline plant, conditions present a *real challenge* . . . a particularly tough one . . . and Clark Compressors were given the job!

For here, in Crane County, Texas, Gulf is working with a two percent hydrogen sulfide gas. And Gulf is drawing this gas (containing 980 lbs. of water vapor per million cu. ft.) from seven different fields . . . a condition which naturally involves considerable variation in the composition of the stream and is bound to affect the constancy of operating results.

So, as one would expect, a complex problem was faced in meeting the three-compression-stage requirements. But the fact that Gulf is experiencing highly satisfactory performance from Clark Compressors in other installations . . . the fact that Clark "Big Angles" are widely known for their great flexibility of compressor cylinder staging — their smooth, flexible operation under varying pressure conditions — their super power and compactness that effect savings in building, foundation and maintenance — *all played a part in Gulf's decision to go to Clark!* Nine Clark 2-cycle, BA-6, gas-engine-driven compressors, 1200 bhp each, are doing the job with eminent success.

Complete data and literature on Clark Compressors are obtainable from your nearest Clark representative.

SEE the difference in

CLARK COMPRESSORS

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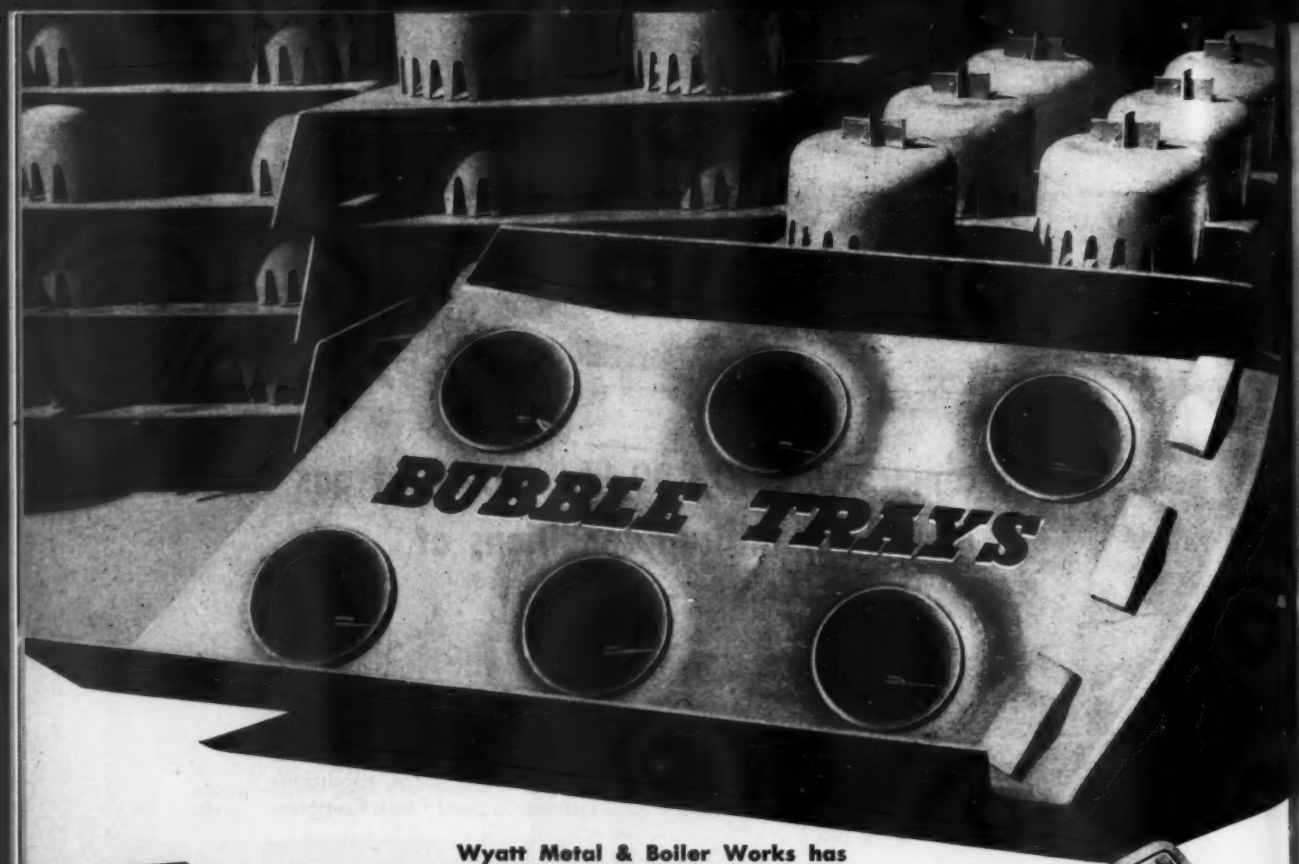
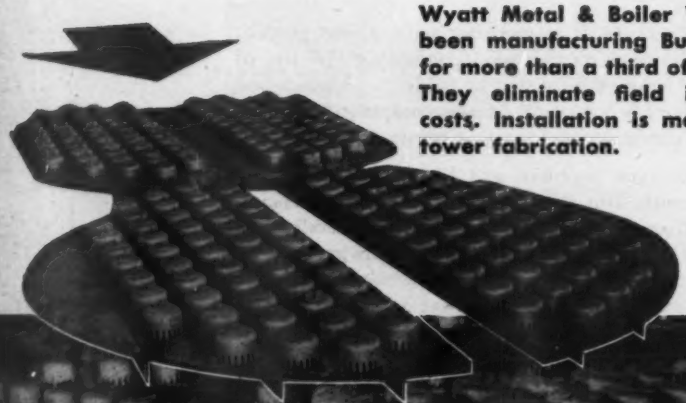


Wyatt Metal & Boiler Works has been manufacturing Bubble Trays for more than a third of a century. They eliminate field installation costs. Installation is made during tower fabrication.



Wyatt's

HOUSTON-DALLAS-NEW YORK-TULSA

Fabricators a
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XUM

Five Ways to Measure the REAL ECONOMY of Process Pumps

1. SAFETY —With I-R refinery pumps, there's no possibility of hazardous leakage at any point. The extra-strong casing, with single ring joint, is easily kept tight. Ample cooling, pressure breakdown and effective sealing minimize stuffing-box seepage. All pumps may be furnished with the Cameron Shaft Seal.

2. DEPENDABILITY —To assure maximum continuity of service, these pumps are designed and constructed with materials to withstand the most severe service conditions. Heavy shaft, mechanically and hydraulically balanced impellers, and water-cooled, oil-lubricated bearings permit trouble-free operation at liquid temperatures up to 800°F.

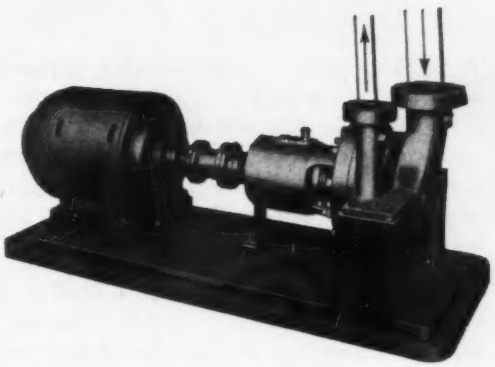
3. LOW MAINTENANCE —These pumps are constructed to last longer. Their overall simplicity with all parts easily accessible means less outage for inspection and maintenance. The bearing cradle and rotor can be removed without disturbing piping connections or motor. The single casing joint, with metal-clad ring gasket, is easy to open and re-seal.

4. SUSTAINED HIGH EFFICIENCY —I-R process pumps are designed and built to retain their original high efficiency over years of operation. This means lower power cost per gallon moved—over a longer period of time.

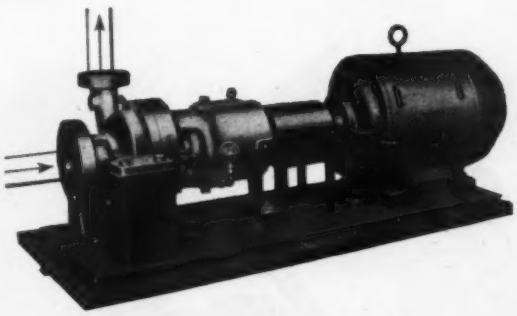
5. EASY INSTALLATION —Flexibility of suction and discharge arrangement makes these pumps adaptable to any piping layout. Various types of nozzle flanges are available to meet your exact requirements.

These five factors add up to real, long-range economy. That's why so many refineries and process plants have installed Ingersoll-Rand pumps. Your nearest I-R representative will be glad to give you complete details, and help you with any application problems you may have.

Ingersoll-Rand pumps rate highest on every point



With top (or bottom) suction and discharge.
Capacities—to 1100 gpm.
Pressures—to 275 psi.



With end suction and top discharge.
Capacities—to 3200 gpm.
Pressures—to 275 psi.

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Cameron Pump Division
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Turbo-Blowers • Condensers • Air & Electric Tools • Hoists
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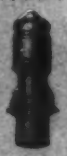
571-10

THERE'S AN I-R PUMP FOR EVERY REFINERY NEED

Single-stage, vertically split
Capacities—20 to 3000 gpm.
Pressures—to 300 psi.

Single and two-stage, horizontally split
Capacities—20 to 3500 gpm.
Pressures—to 500 psi.

Multi-stage, with cylindrical "double-case" construction
Capacities—to 2800 gpm.
Pressures—to 3000 psi.



Multi-stage, vertical type
Capacities—10 to 400 gpm.
Pressures—to 1500 psi.

Vertical, turbine-type—1, 2, 3 or more stages
Capacities—60 to 3500 gpm.
Pressures—to 500 psi.

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Aims like a gun . . . trigger-quick action . . . hits target instantly, accurately . . . discharges one quart of Fire-Gun Fluid . . . compressed air expelled . . . no pumping . . . excellent range 25 to 30 ft. . . . operates with one hand . . . easily recharged . . . can be pressurized by any standard air chuck exerting 150 psi . . . will not freeze.

This is the newest and most effective one quart fire extinguisher for Class B and C fires we have yet designed. Inspected and approved by Underwriters Laboratories.

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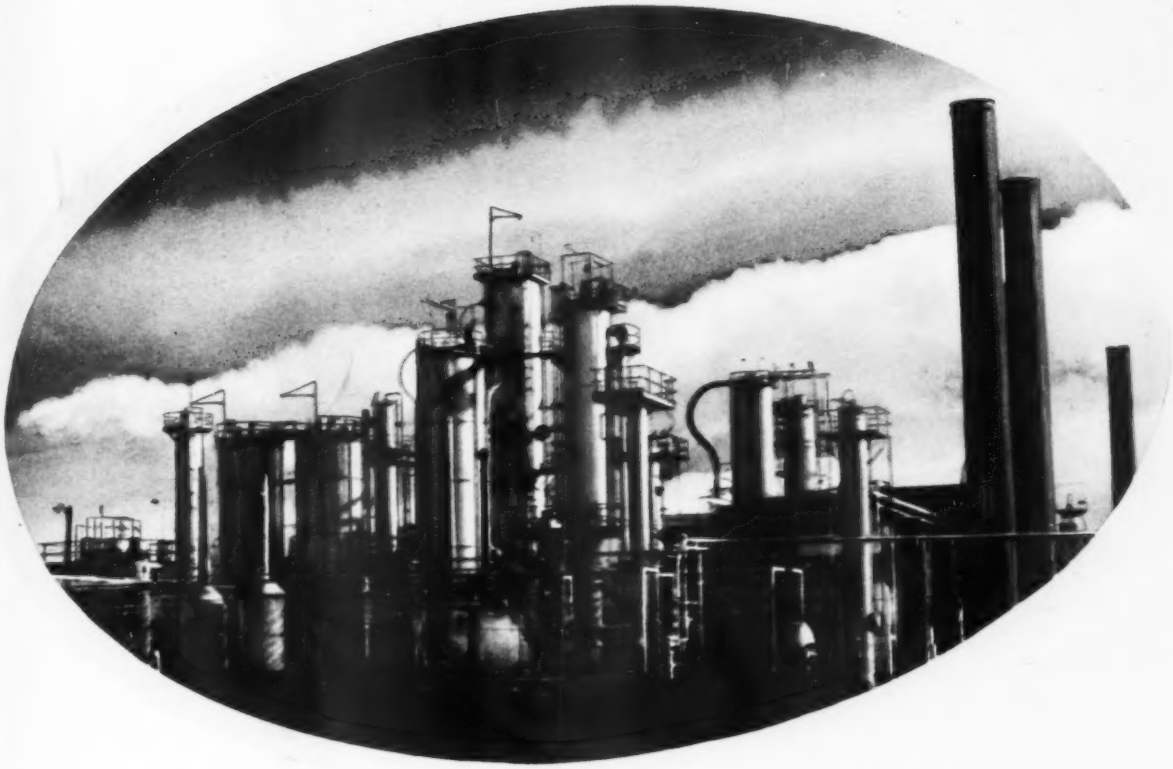

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Maintenance men in the refining and petrochemical industries know that Continental's 72 stores and offices . . . Continental's complete stocks, fast delivery and high quality . . . all help them to maintain capacity production, *all* the time!

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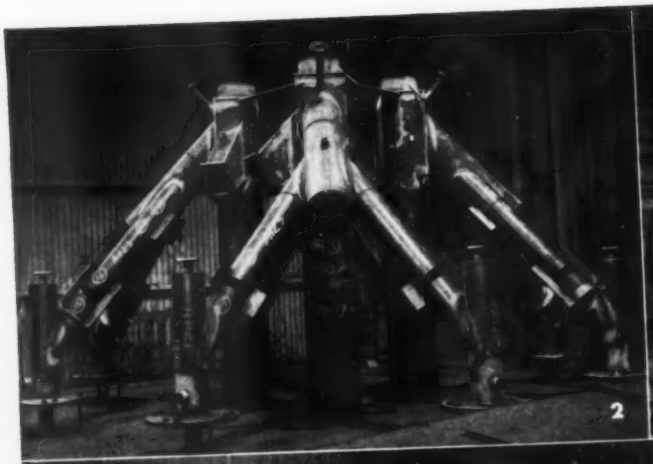

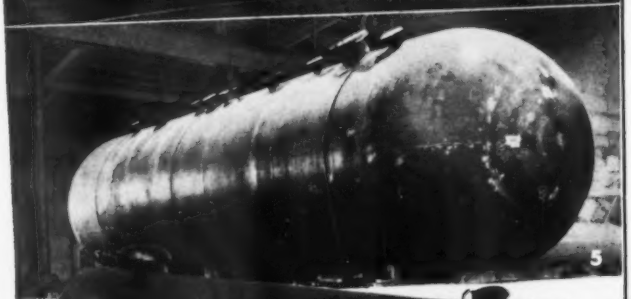

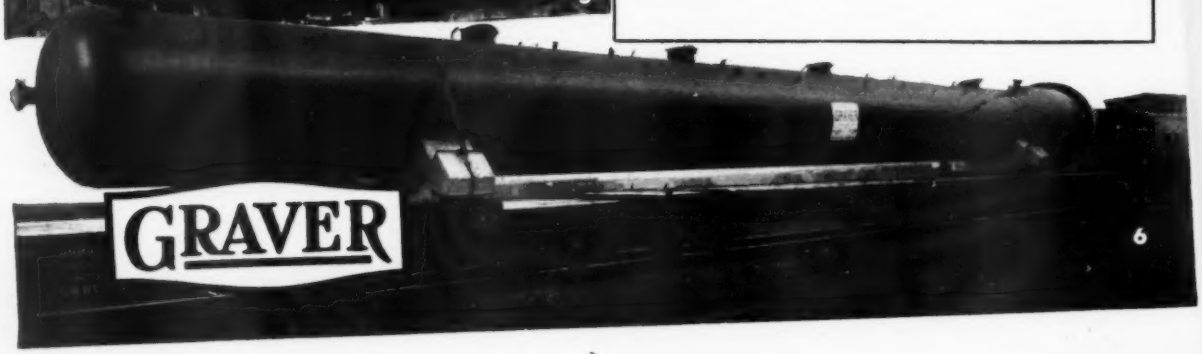

RECENT REFINERY VESSELS FROM GRAVER SHOPS

These pictures show the significant part Graver is taking in the modernization and expansion of the nation's refinery facilities.

1. Two sections of a Separator Surge Tank, 14′0″ x 35′2″
2. Part of a Catalyst Airlift
3. Fines and Fresh Catalyst Storage Bin, 12′0″ x 48′3″
4. Houdry Process Vessel of molybdenum steel, 12′0″ x 50′0″
5. Desalting Tank, 12′0″ x 40′0″
6. Refinery Tower, 7′0″ x 102′11″

These fabrications are exhibits of Graver versatility and indicate the extent of Graver Services to the petroleum industry.

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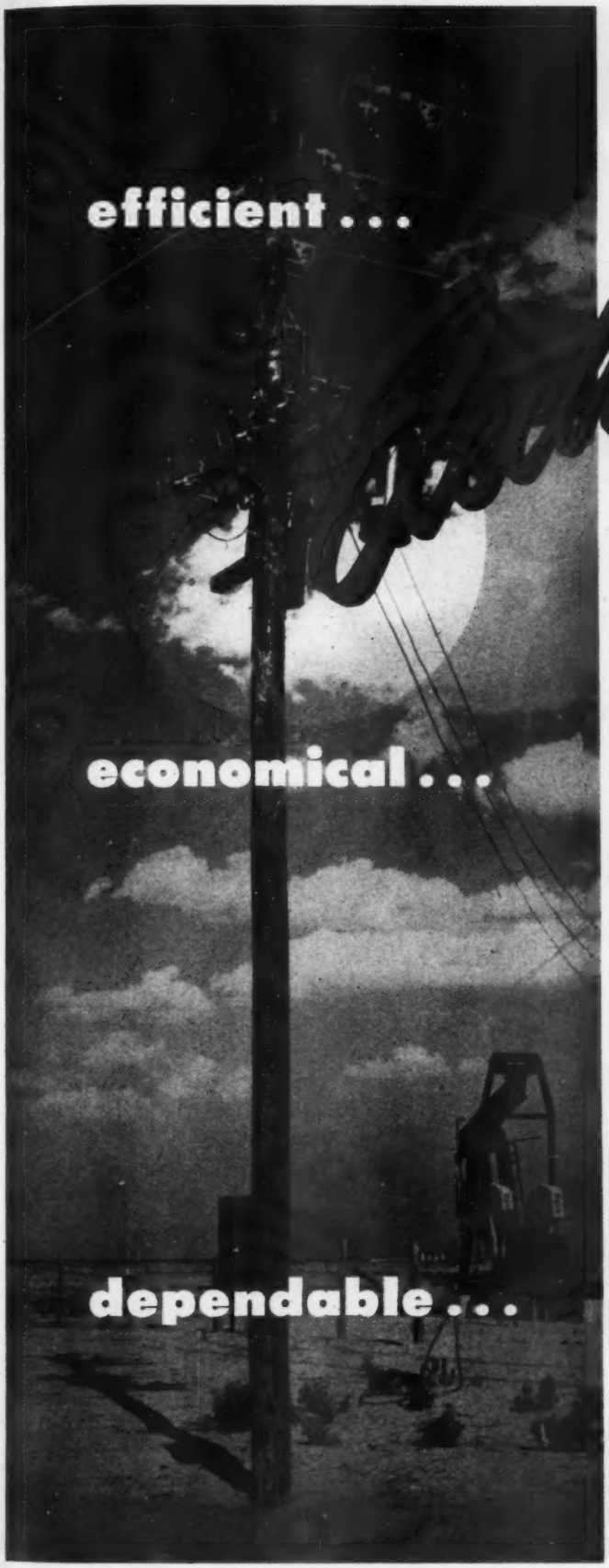
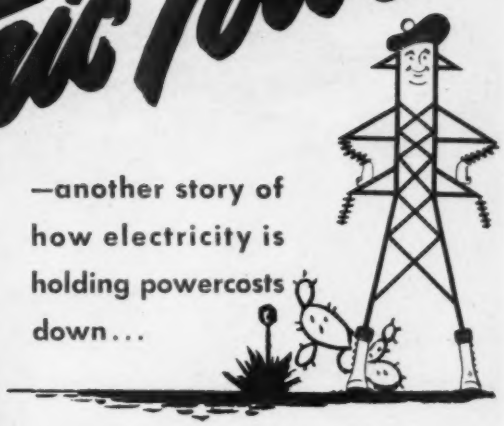


West Texas Pumps with Electric Power



—another story of how electricity is holding powercosts down . . .

Regardless of the locale, climate or conditions, you'll find ELECTRIC POWER efficient, dependable and at rock bottom in cost. The scene at the left is in the famed Permian Basin of West Texas, which is known for its cactus, mesquite and sandstorms as well as its oil. Here ELECTRIC POWER is on the job in every operation of the Petroleum Industry. Call the Power Engineer of your Utility Electric Power Company and let him show you how to cut down your power costs.

Petroleum Electric Power ASSOCIATION

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IN THE INTEREST OF GREATER SERVICE
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Powell Valves for the Petroleum Refining Industry include not only a complete line of standard valves of all types but also many special designs to meet the latest requirements of the modern refinery.

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New 150-pound O. S. & Y. Gate Valves. Available in a wide selection of corrosion-resisting alloys. Made with either flanged or screwed ends. Sizes ¼" to 2", incl. All dimensions of flanged end valves conform to MMS Standard SP-42 and ASA B16.

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"HEAT-SHAPED"
PISTON RINGS

Worried about SCUFFING during the break-in period?

Let PEDRICK engineers help you in this and other piston ring problems.

In *two* distinct ways, Pedrick engineers have helped engine builders and engine users lick the old problem of scuffing.

In the first place, Pedrick's exclusive "Silcoating" process . . . developed by the pioneers of piston-ring coatings . . . assures an intermediate layer that prevents the split-second welds between ring and cylinder wall that cause scuffing.

In addition, Pedrick has developed rings so conformable that they provide a new concept of efficient oil control . . . lubrication where you need it, when you need it, to prevent scuffing. These rings allow sufficient oil for proper top cylinder lubrication, yet prevent excessive oil consumption.

Pedrick engineers will be glad to work with you in overcoming such problems as scuffing. They'll demonstrate the advantages of "Silcoating," Pedrick's exclusive surface treatment of rings, especially developed to inhibit scuffing and provide longer wear. They'll show you how Pedrick rings compensate for block distortion, reduce oil consumption, and take care of your other piston ring problems. With 31 years of unvarying specialization in the piston ring field, Pedrick has the know-how to supplement your own experience and ingenuity. Address your inquiry to WILKENING MANUFACTURING Co., Philadelphia 42, Pa. *In Canada:* Wilkening Manufacturing Co. (Canada) Ltd., Toronto.

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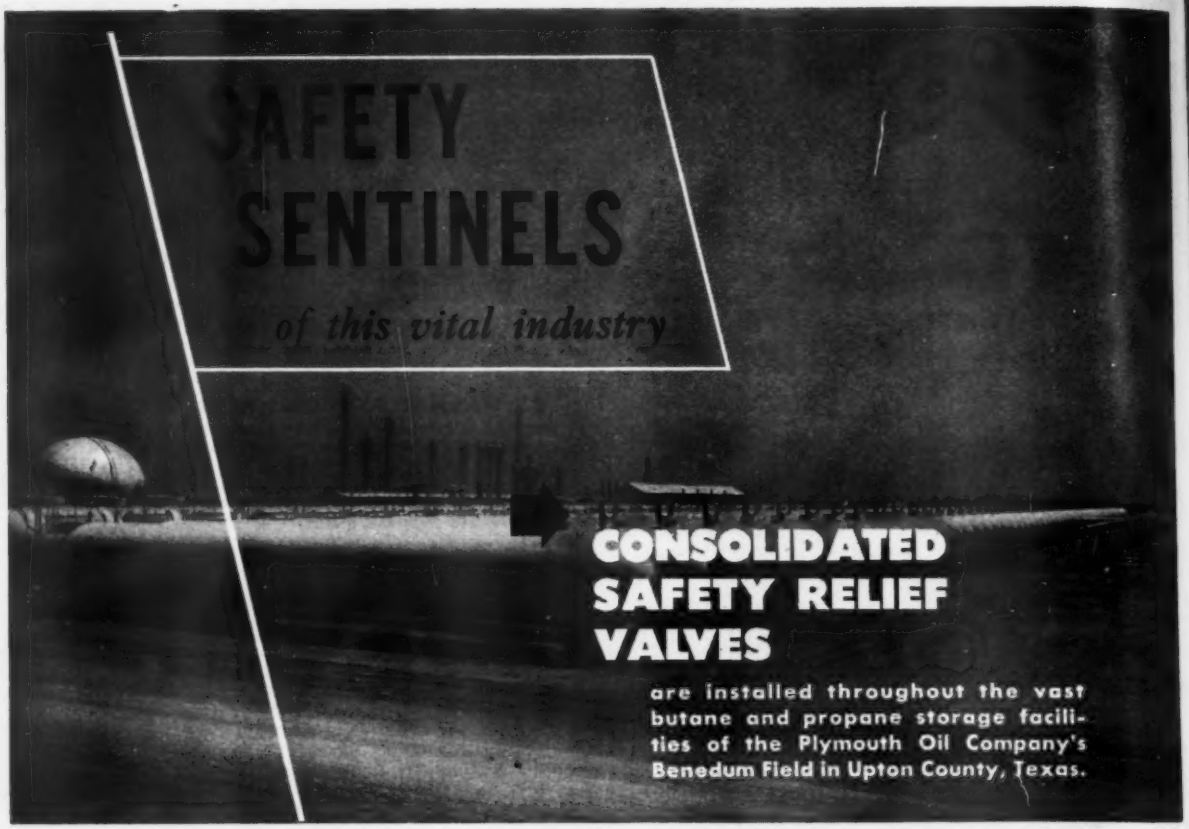
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of this vital industry
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VALVES
are installed throughout the vast butane and propane storage facilities of the Plymouth Oil Company's Benedum Field in Upton County, Texas.

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As the nation's industries prime themselves for defense-geared demands upon their capacities, every item of new equipment or rehabilitation must measure up . . . must be of time-proved durable efficiency. Nothing less will do.

In the vital petroleum industry, where safety plays a "key" role in how well the demands will be met, CONSOLIDATED SAFETY RELIEF VALVE design and construction are recognized as the key to safety *regardless of the severity of installation conditions!*

The outside bevel seat and floating guide construction of Consolidated Safety Relief Valves positively eliminates leakage under discharge piping stresses. Only Consolidated Safety Relief Valves have the exclusive *extra* safeguard of built-in fixed capacity, independent at all times of the position of multiple adjustable blow-down rings. One adjustment controls blow-down to avoid accidental alteration during maintenance. Lift or secondary annular orifice area is not disturbed.

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Whatever the stress of the times may be, it will pay to keep uppermost in mind that safety is the key to protecting your people and keeping all processing at a consistently high level of efficiency . . . with CONSOLIDATED SAFETY RELIEF VALVES.

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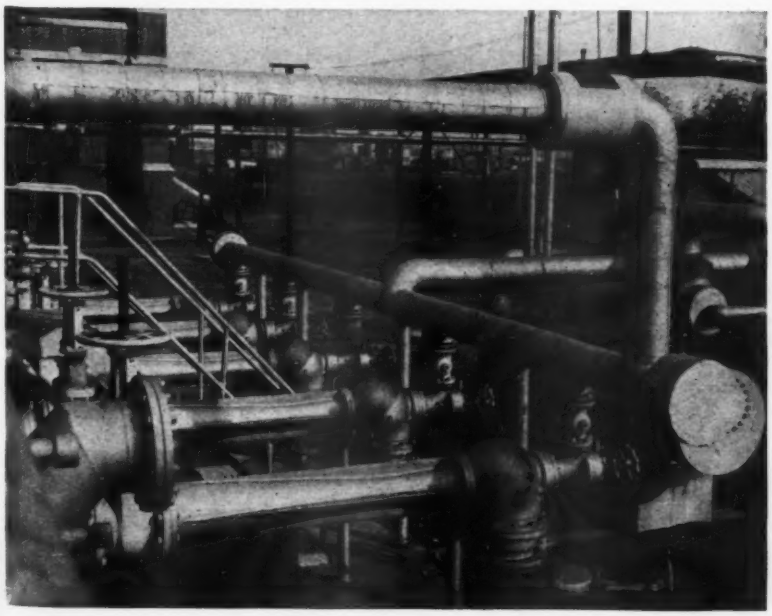
JET COMPRESSORS EASE PEAK LOADS FOR GAS CO.

The illustration shows a typical arrangement of SK Gas Jet Compressors at the plant of The Brooklyn Union Gas Company and indicates how more and more companies are making use of the operating efficiencies and economies offered by these compressors in meeting peak load conditions.

All five gas compressors shown are being used to mix Butane or Propane with atmospheric air and to discharge the mixture against a maximum of 9/10 of a pound back pressure. At installation, the control valves on the suction lines were adjusted for operation at the required heating value. In this case, the Butane or Propane passes from the vaporizer into a header which supplies all five compressors. This gas, at 45 psi gauge, entrains atmospheric air in desired proportion and, once adjusted, operates at a fixed ratio giving constant Btu discharge. A spindle in each nozzle allows adjustment for using Butane or Propane. Each of the units shown has a capacity of 210,000 standard cubic feet of mixed gas per hour at 540 Btu per cubic foot. Control in this installation is manual although SK Gas Jet Compressors can be controlled automatically.

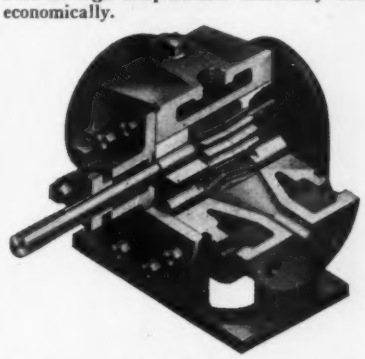
Another advantage of these compressors is the fact that they eliminate the need for a mechanical compressor or blower on the atmospheric air inlet. The plug valve in the L-P line is used to place each compressor in operation and one through five of the compressors can be operated as conditions necessitate. The integral check valves prevent back flow to atmosphere.

For details on SK Gas Jet Compressors, request Bulletin 4-F.



Steam Jacketed Pump Handles Viscous Liquids At High Temperatures

The SK Steam Jacketed Herringbone Gear Pump shown in the break-away drawing is designed to handle viscous liquids such as slop oils, asphalts, tars and waxy materials at high temperatures efficiently and economically.



To insure even thermal distribution, the steam jacket on the pump completely covers the internal parts. The inlet, outlet, and cover flanges are cast integrally with the pump base, and rigid housing construction eliminates any possibility of distortion due to pipe line strain or misalignment. Straight bore housing also prevents shaft deflection and bearing overhang.

Shafts are of heavy duty alloy steel, finish ground. Pressure on the stuffing box is dissipated through a channel in the cover plates. Steam connections on the jackets are designed to permit a variety of piping arrangements. Complete rotor and bearing assembly can be removed as a unit by releasing the coupling and removing the rear cover.

Pumps are available in Meehanite B, cast steel, bronze, or special alloy case. Internal parts are built to specifications.

For details on SK Steam Jacketed Pumps, request Bulletin 17-A, Supplement SJ.

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SAVES UP TO $800.
PER WELL • PER YEAR

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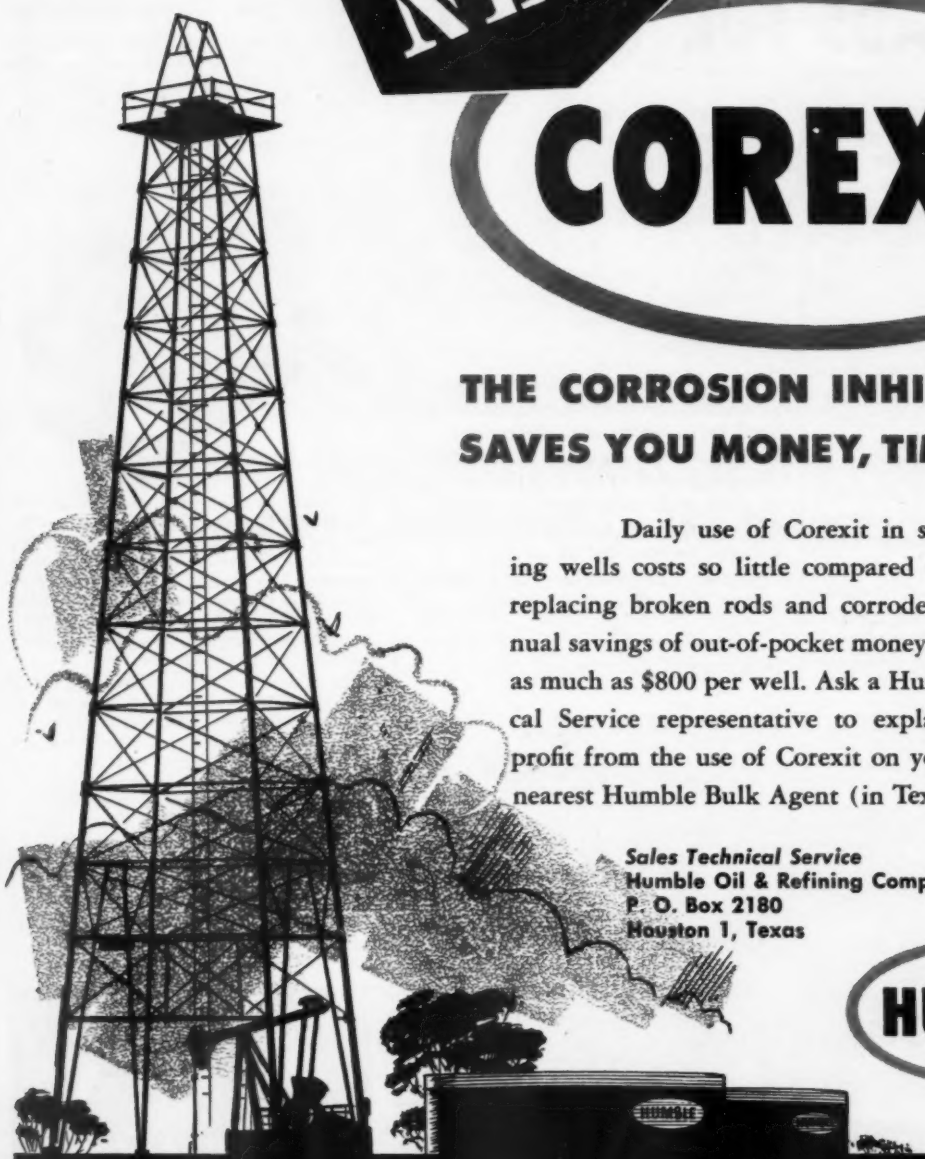
COREXIT



THE CORROSION INHIBITOR THAT SAVES YOU MONEY, TIME, TROUBLE

Daily use of Corexit in sour crude, pumping wells costs so little compared to the expense of replacing broken rods and corroded tubing that annual savings of out-of-pocket money have amounted to as much as $800 per well. Ask a Humble Sales Technical Service representative to explain how you can profit from the use of Corexit on your lease. Call the nearest Humble Bulk Agent (in Texas) or write to:

Sales Technical Service
Humble Oil & Refining Company
P. O. Box 2180
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In whatever direction the upward trend of ... and accompanying total crude capacity, catalytic cracking facilities, plants for making high quality aviation gasoline, petroleum chemicals units—you'll find Lummus well able to fulfill the different requirements imposed by years-ahead engineering.

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That is what the carefully patterned mazes of refinery equipment, produced by Sun for many leading refineries, mean for America.

These towering refineries mean light, heat, comfort and power for the nation's homes and industries . . . fuel for transportation by ship, rail and motor car . . . mobility for our naval and military forces.

They must not fail . . . *they will not fail!* Into their making have gone Sun's engineering skill and craftsmanship, time-tested in wide fields of mechanical production . . . in refinery and chemical plant equipment, in shipbuilding, in fabricated steel work, in the renowned and powerful Sun-Doxford marine Diesel engines and other specialized machinery.

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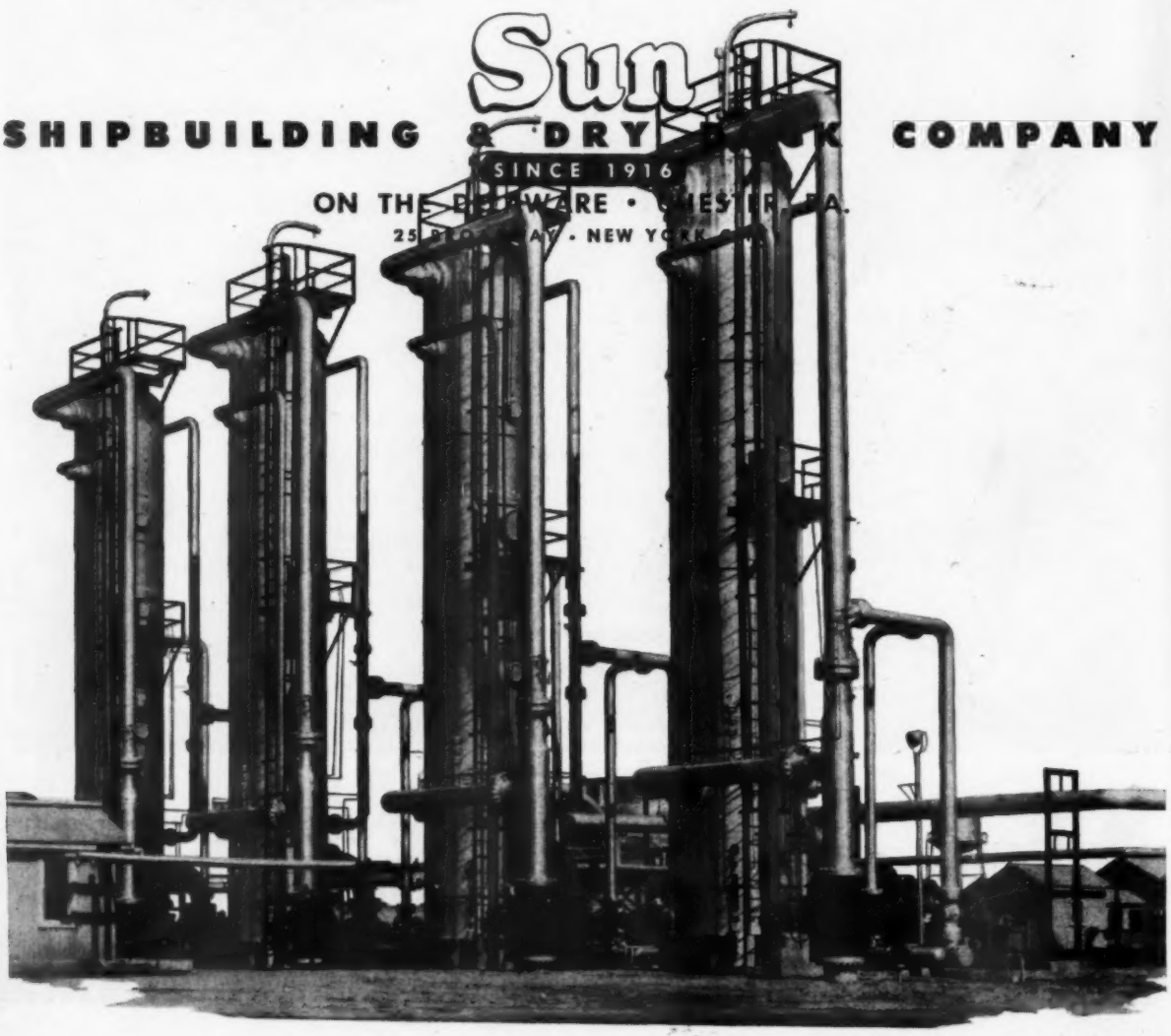
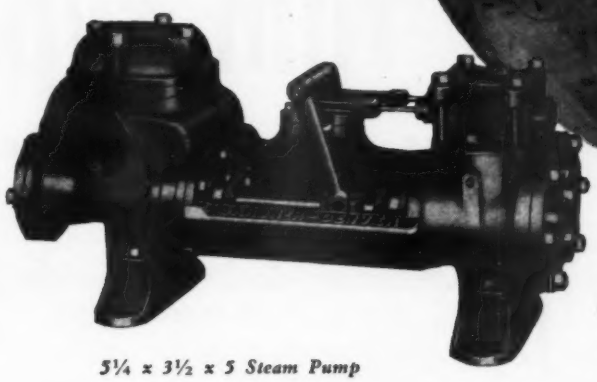
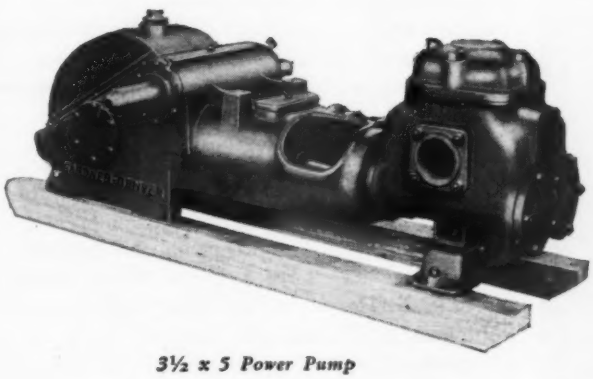


2-Way Economy with GARDNER-DENVER Boiler Feed Pumps



5¼ x 3½ x 5 Steam Pump



3½ x 5 Power Pump

1. POWER ECONOMY! Gardner-Denver Steam Pumps have short and direct steam ports for greatest steam economy. The steam valves stay tight at all steam pressures.

Gardner-Denver Power Pumps are equipped with friction-defying Timken tapered roller main bearings. Herringbone gears and large eccentric bearings transmit more of the power into useful pumping.

2. IN THE SIZE YOU NEED! Gardner-Denver Boiler Feed Pumps are manufactured in a wide range of sizes, for any type of drive. Our pumping experts will gladly help you select just the right combination for maximum economy in your plant.

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SINCE 1859

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THE QUALITY LEADER IN COMPRESSORS, PUMPS AND ROCK DRILLS

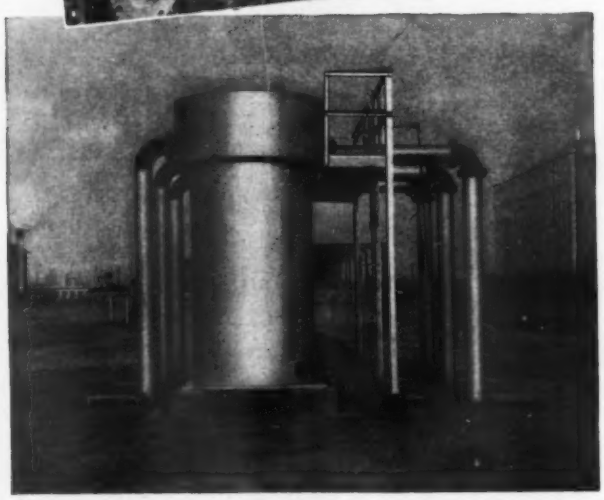
Dirty Water can't "Shut-down"...

Vogt

film type exchangers

(Condensers—Coolers—Evaporators)

Patent Nos. 1,935,270 - 2,057,597 - 2,424,441



River water, well water or brackish water are all alike to this exchanger *because it can be cleaned* while in operation! The water distributing ferrules need only be removed successively for the cleaning brush or tool whereby the tubes receive additional water which sluices away the dislodged dirt.

Vogt Film Type Exchangers are operating with real economy of first cost, operation and maintenance in power, petroleum, and chemical industries. They serve as Jacket Water Coolers, Feed Water Heaters, Hydrocarbon Evaporators, Sulphuric Acid Coolers, and Sulphur Dioxide Condensers, and can be designed to cool or heat any liquid and to condense or evaporate any fluid.

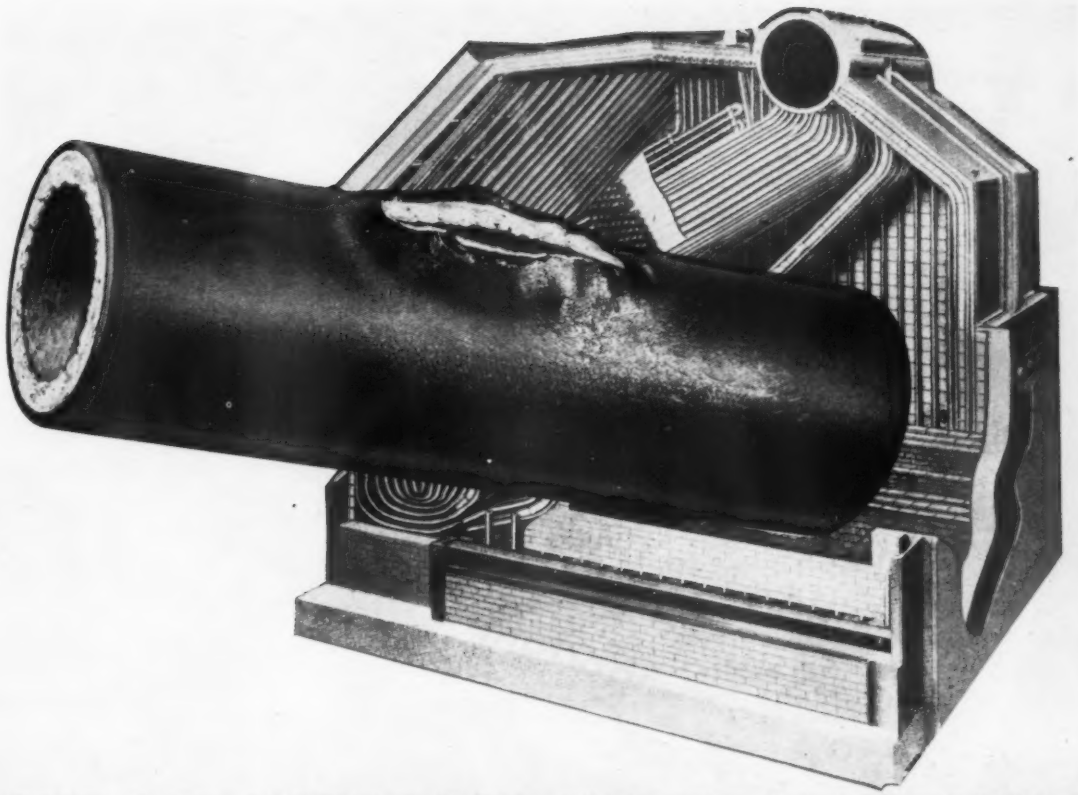
TOP: *Four units at Newton Falls, Ohio Municipal plant cool water for diesel engines and a lubricating oil cooler.*

BOTTOM: *Jacket Water Coolers serving engines of 7,300 HP in the compression plant of a Western Oil Refinery.*

[Bulletin HE-7 describes typical installations of Vogt Film Type exchangers and is available upon request.]

HENRY VOGT MACHINE CO., LOUISVILLE, KY.

Branch Offices: NEW YORK, CHICAGO, CLEVELAND, DALLAS, PHILADELPHIA, ST. LOUIS, CHARLESTON, W. VA.



DON'T LET IMPROPER WATER TREATMENT SABOTAGE YOUR BOILERS

This year, the weakest link in your production program may be *one* boiler tube! The loss of that tube will slow vital production . . . will take longer to replace . . . will cost more.

Modern, up-to-date water conditioning, such as the Drew System, prevents tube failures. Drew's continuing research, its study and investigation of *your* operating and water conditioning problems in its laboratories makes such prevention possible. Drew *insures* the performance of your water conditioning by its dependable and frequent testing and checking service.

That's why Drew is one of America's fastest growing water treatment companies. Industry's most respected names avail themselves of Drew's specialized service. Do the same. Consult the nearest Drew engineer or write for further information.

Send for the new, illustrated DREW ORGANICS Folder describing the use of organics in modern Boiler Water Treatment. Write today.

POWER DREW CHEMICALS

Power Chemicals Division

E. F. DREW & CO., INC.

15 East 26th Street, New York 10, N. Y.

Nationwide Service in Boiler Water and Cooling Water Conditioning

DREW PRODUCTS

You can make important savings in fuel by taking advantage of the quick heating characteristics of J-M Insulating Fire Brick. These light-weight brick permit a quicker rise to proper operating temperature in the furnace because of their low heat storage capacity, and low thermal conductivity. Where furnaces are being intermittently operated these are two especially important characteristics.

These same insulating materials can also be obtained in large size units called Johns-Manville Insulating *Fireblok*. This product has many advantages over the smaller size fire brick for certain types of jobs . . . from both a construction and stability standpoint. The Fireblok units can be quickly applied because they are easy to cut and fit. Fireblok insulations provide additional heat savings because they reduce the number of joints, and require less mortar for bonding.

It will pay you to let a Johns-Manville insulation engineer explain the many ways in which you can save by using these insulations in your furnaces. Just write for further information to Johns-Manville, Box 290, New York 16, N. Y.

JM PRODUCTS

	JM-1620	JM-20	JM-23	JM-26	JM-28	JM-3000
Densities, lb per cu ft	29	35	42	48	58	63-67
Transverse Strengths, psi	60	80	120	125	120	200
Cold Crushing Strengths, psi	70	115	170	190	150	400
Linear Shrinkage†, percent	0.0 at 2000 F	0.0 at 2000 F	0.3 at 2300 F	1.0 at 2600 F	4.0 at 2800 F	0.8 at 3000 F
Reversible Thermal Expansion, percent	0.5—0.6 at 2000 F	0.5—0.6 at 2000 F	0.5—0.6 at 2,000 F	0.5—0.6 at 2000 F	0.5—0.6 at 2000 F	0.5—0.6 at 2000 F
Conductivity* at Mean Temperatures						
500 F	0.77	0.97	1.51	1.92	2.00	3.10
1000 F	1.02	1.22	1.91	2.22	2.50	3.20
1500 F	1.27	1.47	2.31	2.52	3.00	3.35
2000 F	—	1.72	2.70	2.82	3.50	3.60
Recommended Service						
Back up	2000 F	2000 F	2300 F	2600 F	2800 F	3000 F
Exposed	1600 F	2000 F	2300 F	2600 F	2800 F	3000 F

†24-hr. simulative service panel test for JM-3000; 24-hr. soaking period for other brick.

*Conductivity is expressed in Btu in. per sq ft per F per hour of the designated mean temperatures.

Note: Above tests are in accordance with A.S.T.M. tentative standards.

Johns-Manville *first in* INSULATIONS

ELECTRUNITE TUBES ROLL IN FAST . . . because of their uniformly high ductility—throughout every tube and every shipment. Produced in full range of sizes, gages and analyses . . . carbon steel and Enduro Stainless Steel.

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ELECTRUNITE

BOILER, CONDENSER AND HEAT EXCHANGER TUBES

REPUBLIC STEEL CORPORATION

STEEL AND TUBES DIVISION • CLEVELAND 8, OHIO

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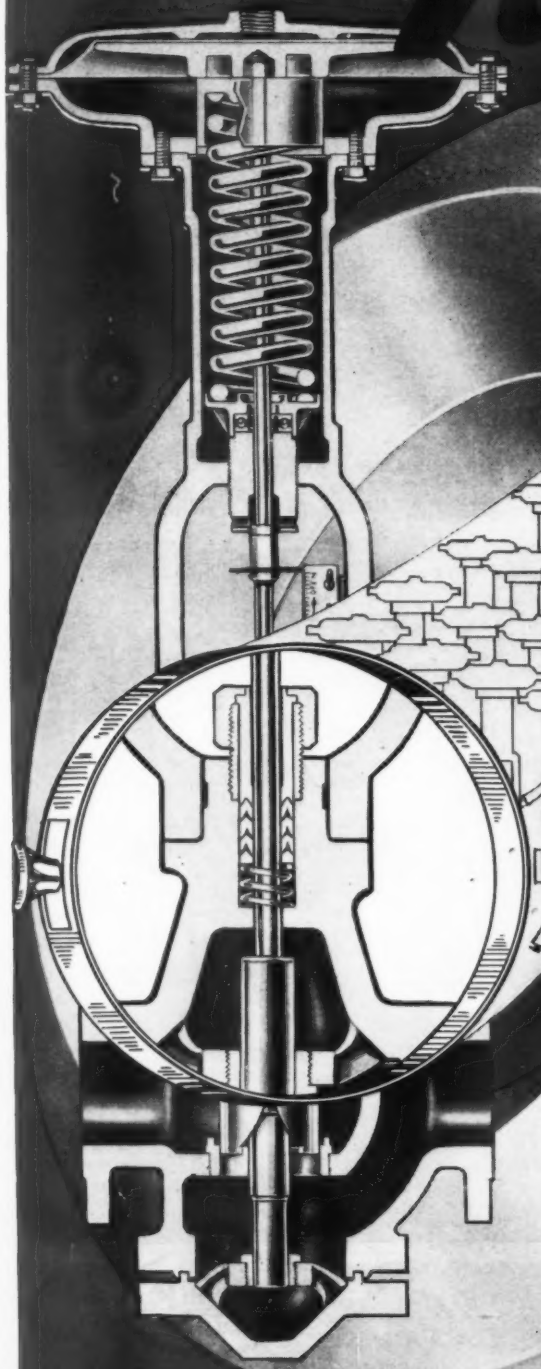
FISHER®

Teflon

V-RING PACKING



. . . LEADING THE MARCH TO BETTER DIAPHRAGM MOTOR VALVE PERFORMANCE

roved by many months of field service Fisher Teflon V-Ring Packing feature

- *No gland leakage.*
- *Used on wide range of pressures w out appreciable change in friction va*
- *Elimination of maintenance an adjustment.*
- *No valve stem lubricators re*
- *Chemically inert to all flui* 450° F.

Fisher Teflon V-Ring Packing is now standard equipment on all Fisher Diaphragm Motor Valves.

Bulletin E-200 gives complete details.

*Teflon is the trade name of E. I. Du Pont de Nemours & Co.

FISHER GOVERNOR COMPANY

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POPULARITY CREATED BY PERFORMANCE

Since Bucyrus-Erie spudders were introduced to the oil fields in 1938, thousands of drilling contractors have recognized the top-notch performance these machines can deliver. Three major factors are responsible for this popularity:

1. BIG CAPACITY

48-L swings 6000 lb. tools, drills to 6000 ft.
36-L handles 4200 lb. tools, drills to 3500 ft.
28-L swings 3000 lb. tools, drills to 2500 ft.
24-L handles 2400 lb. tools, drills to 1500 ft.

2. OUTSTANDING VERSATILITY

Top-to-bottom drilling
Tailing-in
Cleaning-out
Deepening
Servicing
Test Drilling
Reconditioning
Disposal holes

3. EASY MOBILITY

48-L with skid or tandem mounting
36-L with skid, semi-trailer or tandem mounting
28-L with semi-trailer or skid mounting
24-L with truck or semi-trailer mounting

Let the experience of drilling contractors everywhere be your cue to investigate the Bucyrus-Erie line. Your nearest Bucyrus-Erie spudder distributor (see listing on this page) will give you the complete details.

BUCYRUS-ERIE COMPANY • South Milwaukee, Wis.

83550-A

See or Write Your BUCYRUS ERIE Spudder Distributor

BEACON SUPPLY CO. - - - Borger and Pampa, Texas
BECKWITH MACHINERY CO. - Pittsburgh and Bradford, Pa.
BUCKEYE SUPPLY COMPANY - - - Zanesville and Wooster, Ohio; El Dorado and Chase, Kan.
DRILLERS SUPPLY CO. - - - - - - - Joplin, Mo.
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GREAT NORTHERN TOOL & SUPPLY CO. - - - - - - Billings, Kevin and Cut Bank, Mont.; Casper, Wyo.
IVERSON SUPPLY CO. — Oklahoma City, Okmulgee and Tulsa, Okla.; Ft. Worth, Kermit, Odessa, Synder, Houston and Midland, Texas; Artesia and Farmington, N. M.
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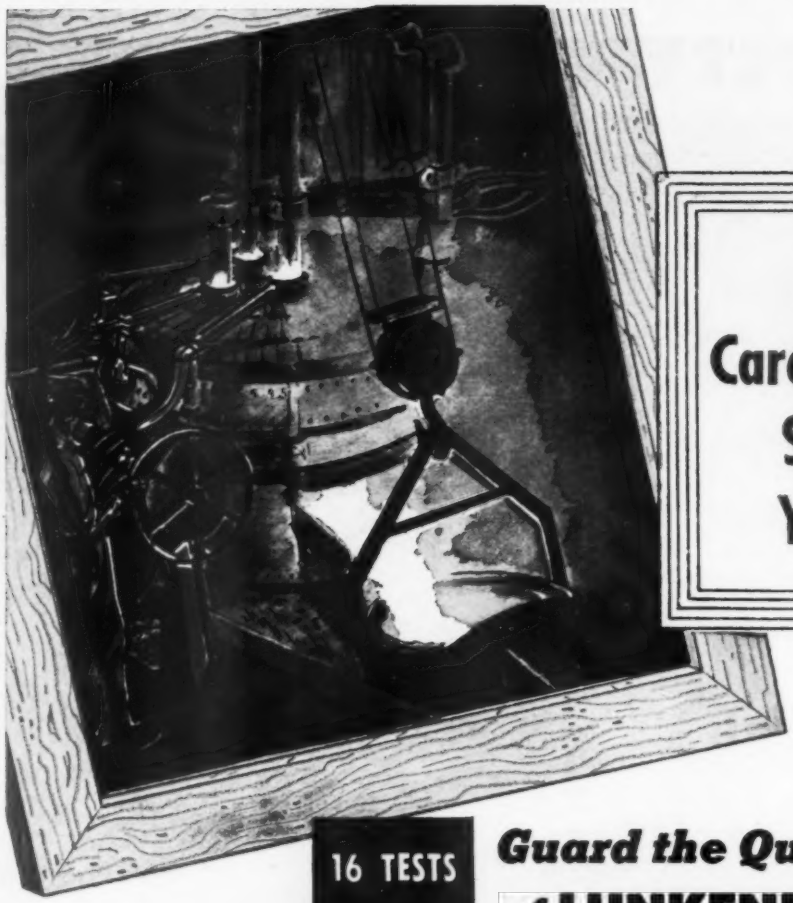

The Most Carefully Built Cast Steel Valves You Can Buy

16 TESTS

Guard the Quality of LUNKENHEIMER

Figure 1938

There is only one passing grade — perfection. When Lunkenheimer steel valves reach you, they have passed a battery of tests that *assure* you of flawless quality. Incoming metals are carefully checked by the laboratory to meet high Lunkenheimer standards . . . furnace temperatures and atmospheres are tested and controlled . . . test-bars from each heat are stretched, twisted, distorted in the laboratory to assure conformance to rigid specifications . . . all pressure-parts are Magnafluxed . . . short wave gamma rays search steel castings in Radiography tests . . . seats and shells are tested hydrostatically, far above rated pressures . . . and seats are air-tested for tightness. When a Lunkenheimer valve finally reaches you, it's the most dense, sound, carefully constructed steel valve you can buy. It is available in sizes from 1½ to 24 inches with flanged or buttwelding ends. Disc guides assure accurate seating, eliminate drag . . . smooth port-to-port flow keeps turbulence down and pressure up . . . rectangular section seat rings seat firmly against the body-wall, prevent distortion.

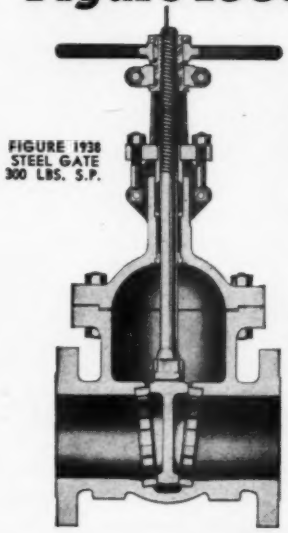

FIGURE 1938
STEEL GATE
300 LBS. S.P.

Write for your copy of "Lunkenheimer Cast Steels," and ask your local Lunkenheimer representative for more information. Address: The Lunkenheimer Co., Box 360F, Cincinnati 14, Ohio.

STEEL • IRON • BRONZE

LUNKENHEIMER

THE ONE *Great* NAME IN VALVES

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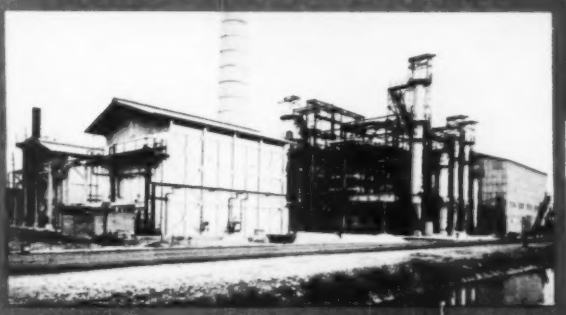
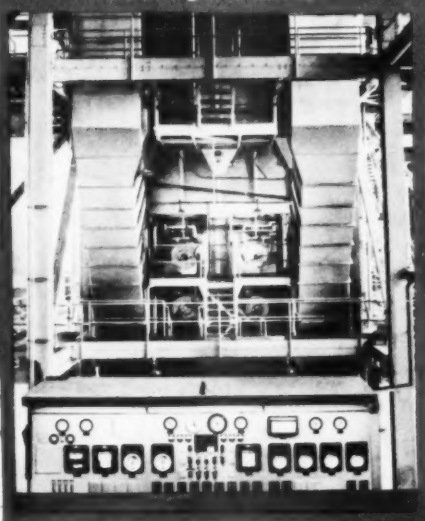
the *complete* engineering service

complete lube oil processing plants



dual-circulation
steam generators



complete chemical plants

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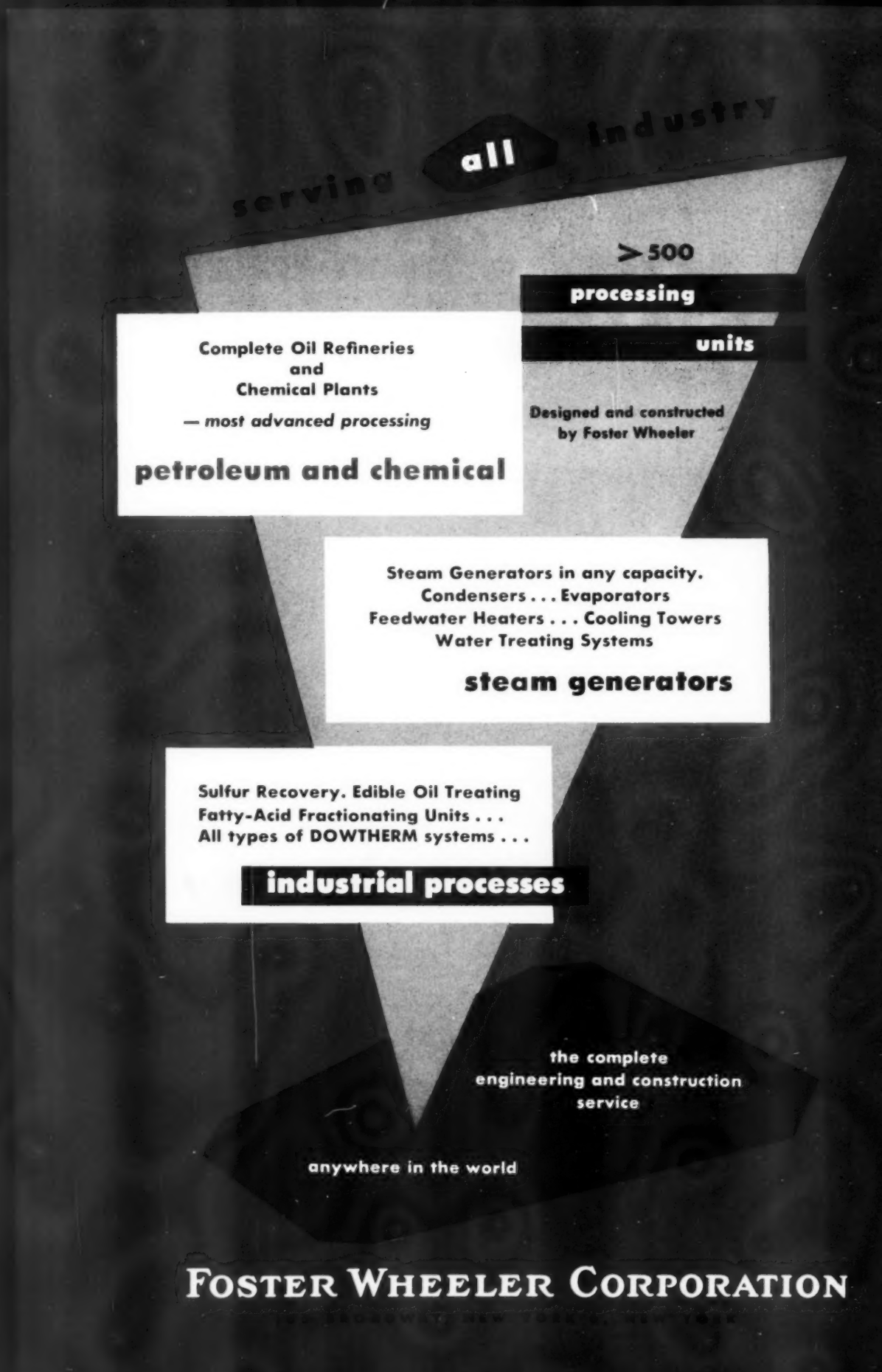
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processing
units
Designed and constructed by Foster Wheeler
Complete Oil Refineries
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Chemical Plants
— most advanced processing
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Steam Generators in any capacity.
Condensers . . . Evaporators
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All types of DOWTHERM systems . . .
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engineering and construction
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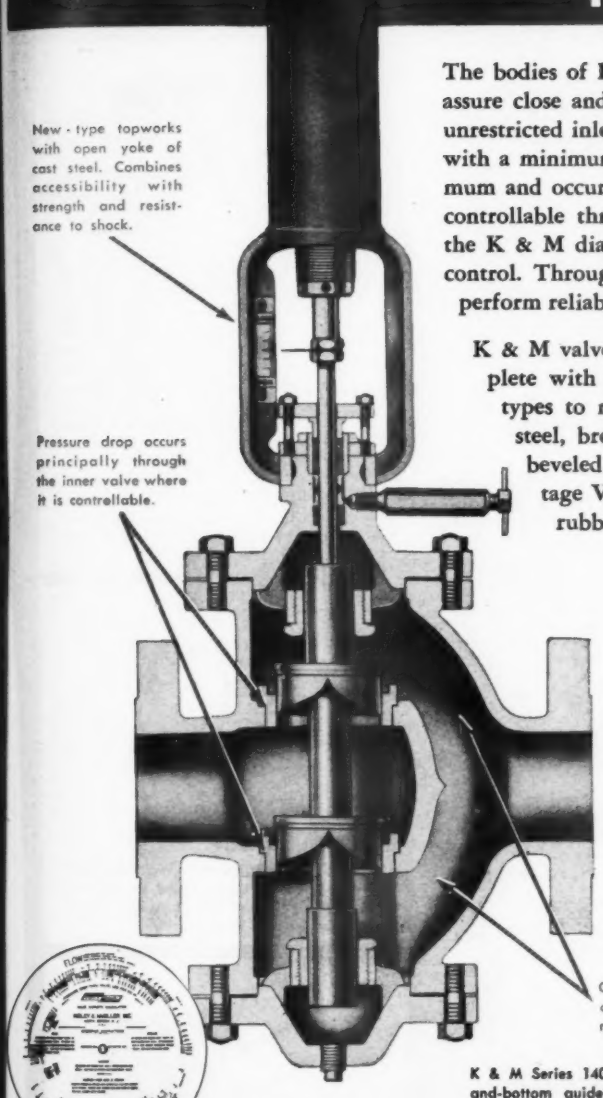
K&M The Control Valves DESIGNED ESPECIALLY FOR INSTRUMENTATION

The bodies of K & M Control Valves are especially designed to assure close and positive control by instrumentation. They have unrestricted inlet and discharge passages and permit smooth flow with a minimum of turbulence. Pressure drop is held to a minimum and occurs principally through the inner valve where it is controllable through the full valve travel. The construction of the K & M diaphragm motors assures extreme precision in this control. Throughout, K & M Control Valves are engineered to perform reliably in *the most exacting applications.*

K & M valves are available in sizes from ½ to 20-inch, complete with diaphragm motor and are made in 13 different types to meet varying requirements. Constructed of semi-steel, bronze, cast steel or special alloys. Inner valves in beveled quick opening, percentage parabolic or percentage V-port design as standard. Facings range from soft rubber to stellite.

New-type topworks with open yoke of cast steel. Combines accessibility with strength and resistance to shock.

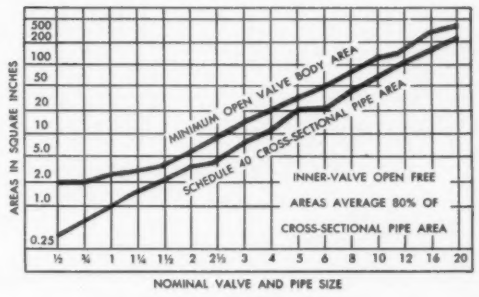
Pressure drop occurs principally through the inner valve where it is controllable.

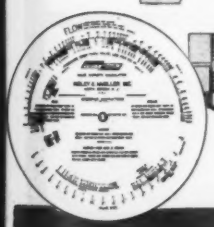


Over-size, streamlined body areas reduce turbulence and friction to a minimum and assure smooth, maximum flow.

K & M Series 1400 top-and-bottom guided diaphragm motor valve.

Because of their modern design, all K & M valve bodies have extremely high capacities in relation to corresponding pipe size:





This extremely accurate circular slide-rule type K & M valve capacity calculator includes correction scales for steam quality, liquid and gas specific gravity and a flowing temperature scale for gases. Sent without charge in response to a request on your business stationery.

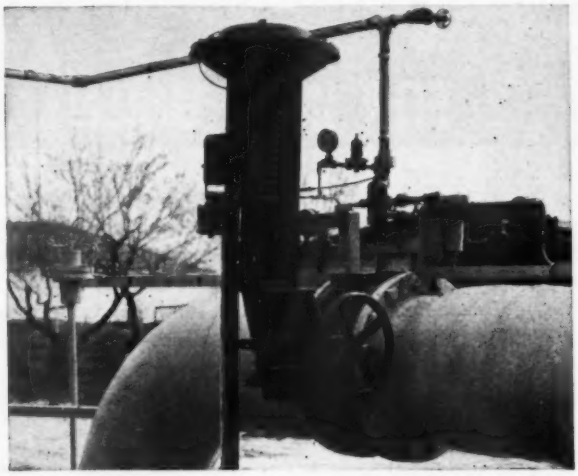
KIELEY & MUELLER

Established 1879

2027 43rd Street North Bergen, N. J.

R-S valvEvents

• EXCERPTS FROM THE R-S BOOK OF EXPERIENCE •



Minimum Pressure Drop

SAVES POWER

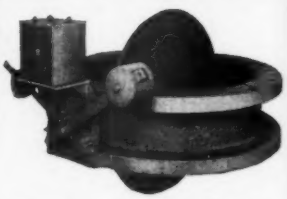
The beveled vane of an R-S Valve seats firmly against the valve body to produce commercially tight shut-off with metal-to-metal seat. A rubber seat produces drip-tight closure. In the open position the streamlined vane creates a Venturi action. Pressure drop in R-S Valves is low, and they therefore produce substantial savings in pumping costs.

Illustration shows a heavy duty R-S Valve used in the water system to a compressor house. Valve is equipped with diaphragm motor, handwheel control with self-locking worm and gear and declutching mechanism together with outboard bearing for operating shaft with goose neck support.

Every R-S Valve is engineered and constructed for rugged service and provided with such safety factors that it will give complete satisfaction in the service for which it is designed. Consult with your local R-S Valve Engineers or write direct.

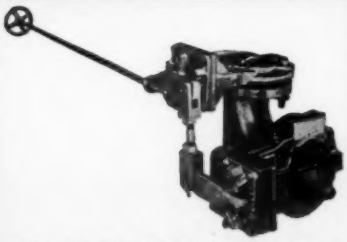
R-S PRODUCTS CORPORATION
4600 Germantown Avenue
Philadelphia 44, Pa.
An S. Morgan Smith Company Subsidiary

No. 579—6-inch 15-pound Direct Action Float Valve with counter-weight assembly.



No. 628—Solenoid Trip Valve is used for emergency service. The solenoid can be arranged with the counter-weight mechanism to open or close the valve and hold it there in one position or the other. If for any reason the solenoid functions, the latch is tripped, which permits the counter-weight to open or close the valve by gravity. The assembly is suited to shut off the flow or to open a vent and requires manual reset. Can be constructed of any metal or alloy and in various sizes for air, gases, steam, oil, hydraulic and other services.

No. 677—1500-pound Welding End Steel Valve for superheated steam service. A.S.M.E. standards with heavy duty handwheel control.



No. 795—Three-inch 3-way Valve Type No. 733 utilizing standard tee and two wafer valves with extended handwheel control.

THIS NEW AUTHORITATIVE **FIELD MANUAL** POINTS THE WAY TO

BETTER PIPE PROTECTION

Even the finest enamel affords no protection until it is *properly* applied to the pipe.

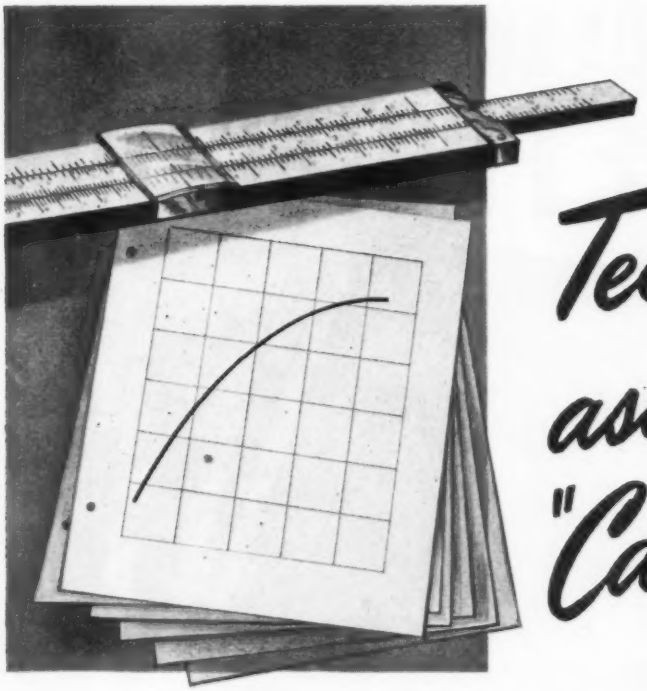
The new Barrett Field Manual covers all phases of the application of Barrett* Enamels from cleaning to back-filling. Specific information is given relative to precoating at plants and yards and reconditioning processes—with quantity requirements. Many excellent illustrations of modern coating equipment are included.

The best protection will result when Barrett Coal-Tar Enamels are used and applied in accordance with Barrett Field Manual instructions and with the help of Barrett Servicemen. Together, these services insure Barrett customers corrosion-proof pipe lines.

A Barrett Field Manual will be sent to pipe line personnel, corrosion engineers and others, free. Write for it on your business letterhead.

Barrett*

THE BARRETT DIVISION
ALLIED CHEMICAL & DYE CORPORATION
40 Rector Street, New York 6, N. Y.
*Reg. U. S. Pat. Off.



Technical assistance on "Cat Cracking"

FILTROL* ENGINEERS HAVE BEEN RESPONSIBLE FOR INTRODUCING PROFITABLE PROCESS IMPROVEMENTS IN COOPERATION WITH MANY REFINERS. THEY HAVE AN INDUSTRY-WIDE BACKGROUND OF REFINING EXPERIENCE IN BOTH TCC AND FLUID CATALYTIC CRACKING THAT CAN BE ADVANTAGEOUSLY APPLIED TO A VARIETY OF YIELD PROBLEMS. THIS FILTROL TECHNICAL SERVICE IS FREELY AVAILABLE TO REFINERS.

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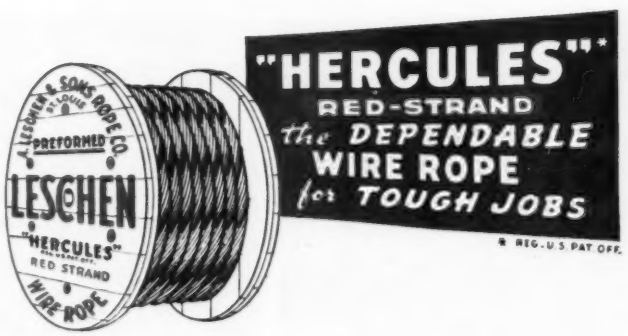
Yes, Just a Piece of Wire BUT...

upon its quality and fabrication depends the kind of wire rope service you will get.



If this wire goes into a rope of the 6 x 19 Seale Construction with a fiber core, it will be just one of 114. But if it is a "HERCULES" (Red-Strand) Wire Rope, *every* one of the 114 wires will have been rigidly tested to make sure that it met, fully, our exacting standards as to *all* essential properties. Furthermore, the rope will have been designed and fabricated according to the most advanced methods of manufacture.

Only by the strict adherence to such principles can the highest quality in wire rope be produced — *consistently*. It is never a matter of chance.

Because of the exacting care and long experience always used in making "HERCULES" (Red-Strand) Wire Rope, you can depend on it for safe and economical service. As it is made in a wide range of construction — either Preformed or Non-Preformed, there is in this one grade, a "Right Rope" for any heavy duty job.

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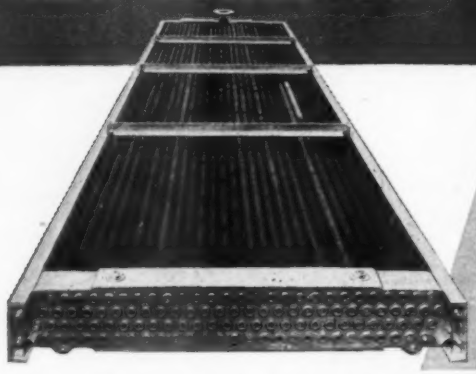
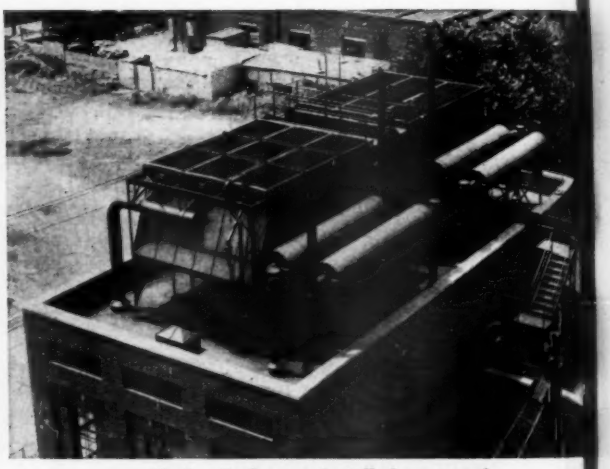
FIN-FAN
AIR-COOLED
HEAT EXCHANGER



G-R K-Fin Air-Cooled Sections used in the Fin-Fan Exchanger

Fin-Fan Exchanger installed within a building



Fin-Fan Exchanger installed on a roof

Large Fin-Fan installation on the ground

GRISCOM-RUSSELL

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AIR...the only cooling and condensing medium that's...

- **FREE**
- **LIMITLESS**
- **UNIFORM**
- **DEPENDABLE**

Every plant designer, construction engineer and maintenance man knows the expenses, complications, and difficulties of water-cooled heat exchangers . . . the required piping, pumping, treatment and disposal . . . the likelihood of corrosion, scaling and freeze-ups . . . the uncertainty of sustained adequate supply.

All these problems are being avoided by plants in every section of the country which use AIR as the cooling or condensing medium . . . in FIN-FAN Air Blast Exchangers.

These exchangers, developed jointly by The Griscom-Russell Co. and Fluor Corp. Ltd., are self-contained package-type units. They include G-R K-Fin Heat Transfer Sections with Fluor air circulation equipment, all mounted in a sturdy compact structure.

You can use Fin-Fan Exchangers on practically any cooling or condensing service. You can put them anywhere . . . on the ground, on a roof, or within a building. You can use a single installation for two or more heat transfer duties.

And these are only some of the many Fin-Fan benefits and advantages. Get the whole story of this important development in heat transfer apparatus . . . write for bulletin and ask for specific recommendations on Fin-Fan for your cooling and condensing needs.

Some of the many services on which FIN-FAN EXCHANGERS are being used

- Exhaust steam condensing
- Engine jacket water cooling
- Engine oil cooling
- Oil cooling for large gear boxes, speed reducers, etc.
- Gas compressor inter and after cooling
- Process gas cooling
- Solution cooling
- Quenching oil cooling
- Still reflux condensing
- Final overhead condensing and cooling
- Refrigeration system condensing
- Gas treating and purification system condensing and cooling

THE GRISCOM-RUSSELL CO. 285 MADISON AVENUE, NEW YORK 17, N.Y.

GR-257

GRISCOM-RUSSELL: PIONEERS IN HEAT TRANSFER APPARATUS

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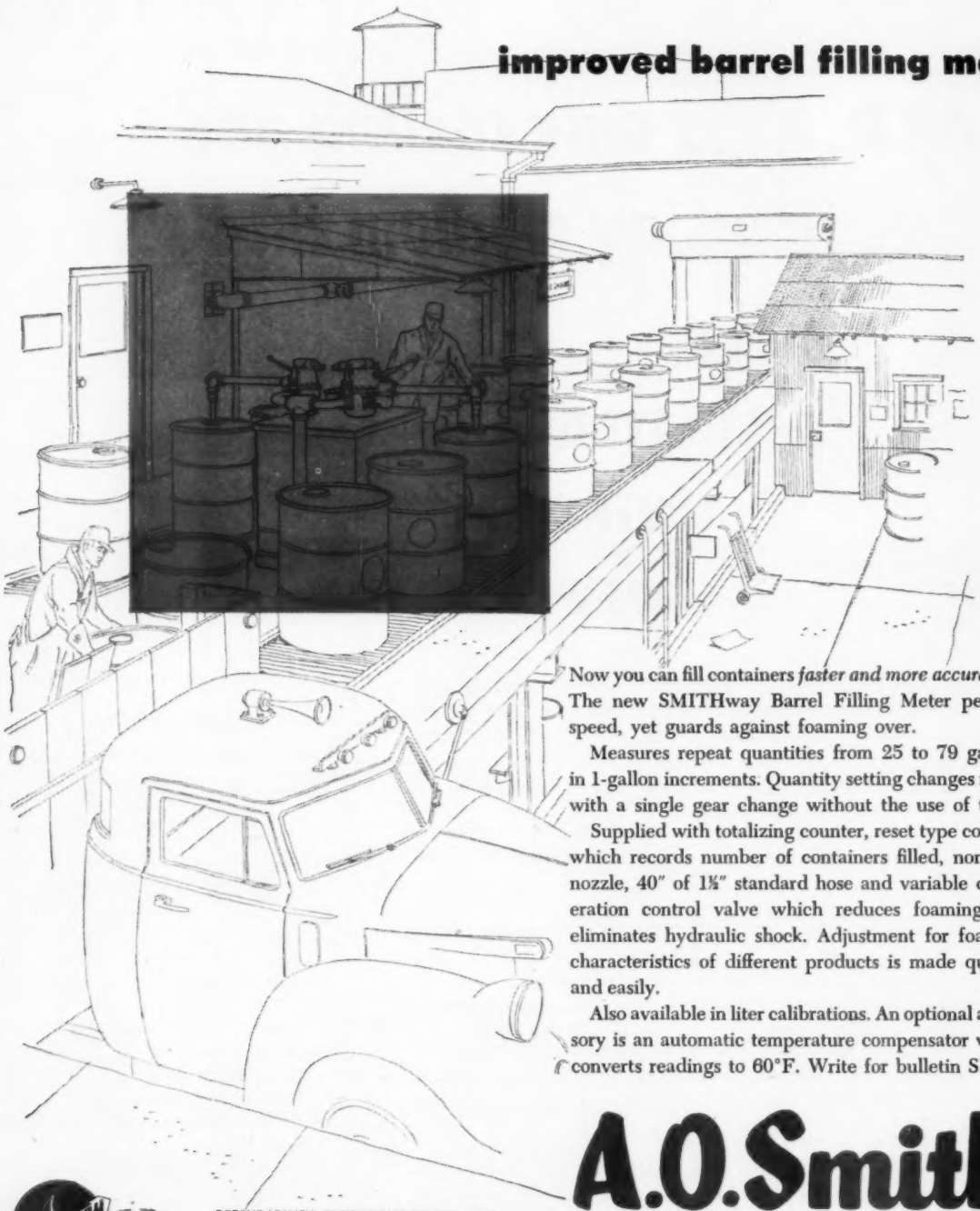
60 G.P.M. CAP. 1½" P.S.

improved barrel filling meter



Now you can fill containers *faster and more accurately.* The new SMITHway Barrel Filling Meter permits speed, yet guards against foaming over.

Measures repeat quantities from 25 to 79 gallons in 1-gallon increments. Quantity setting changes made with a single gear change without the use of tools!

Supplied with totalizing counter, reset type counter which records number of containers filled, non-drip nozzle, 40" of 1½" standard hose and variable deceleration control valve which reduces foaming and eliminates hydraulic shock. Adjustment for foaming characteristics of different products is made quickly and easily.

Also available in liter calibrations. An optional accessory is an automatic temperature compensator which converts readings to 60°F. Write for bulletin SD-70.

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Corporation
METER DIVISION

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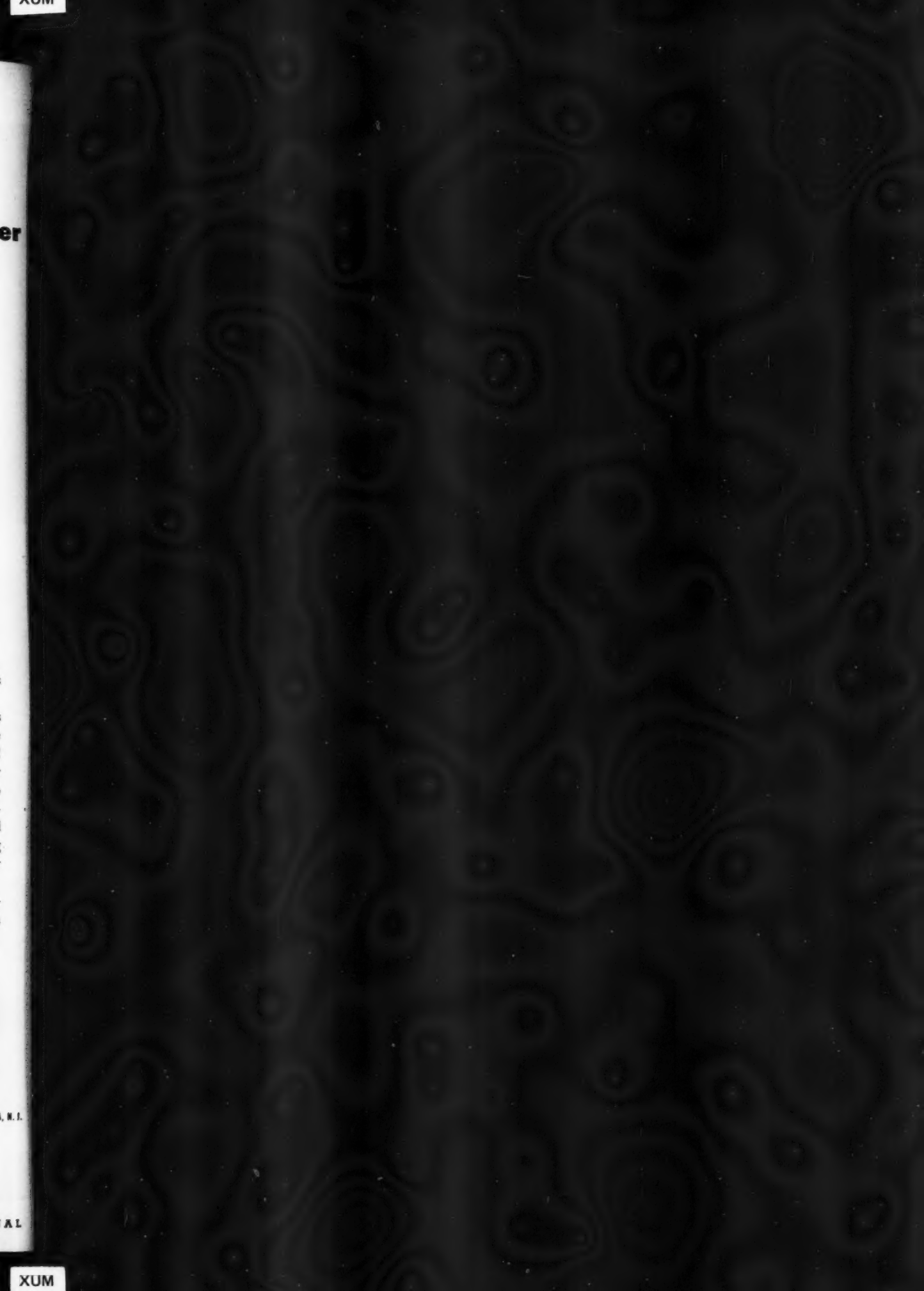
International Division—Milwaukee 1, Wisconsin

Smith Meter 77th ANNIVERSARY 1874 · 1951

DEPENDABILITY THROUGH RESEARCH AND ENGINEERING *To petroleum meters, A. O. Smith devotes the same high standards of research and engineering which have distinguished the products of this firm for seventy-six years.*



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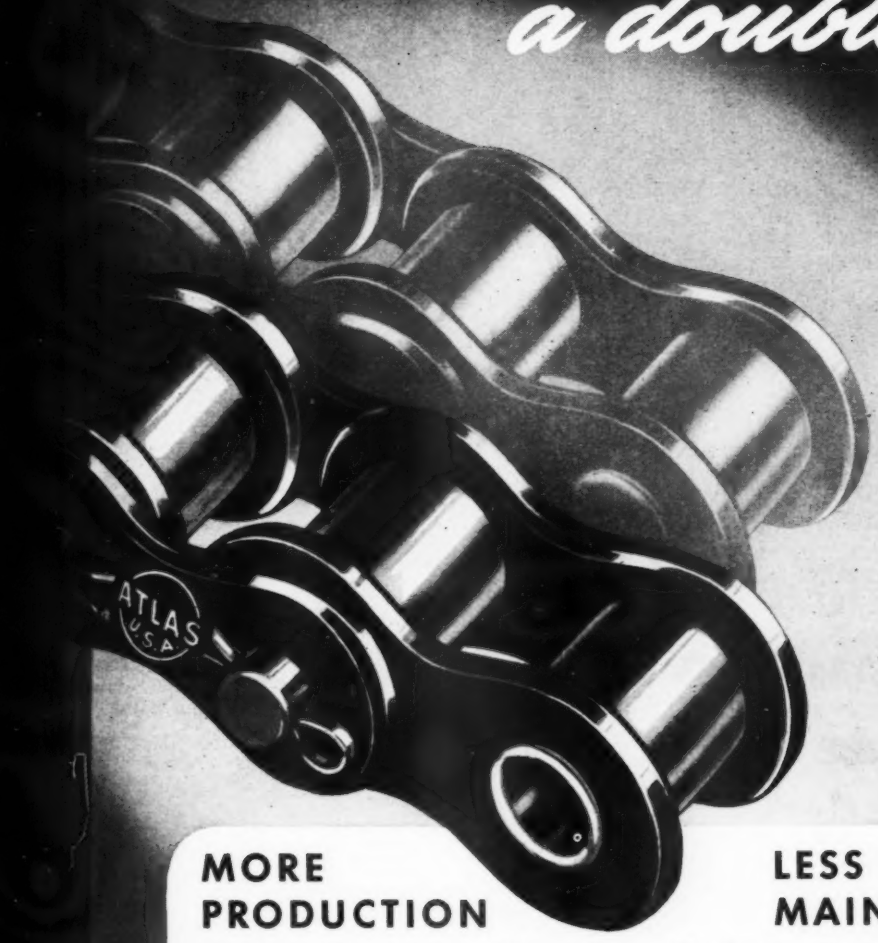
CHAIN THAT LEADS

a double life!



MORE PRODUCTION

Boosting output of present drives! Atlas Roller Chain is bringing this benefit to plants everywhere.

That's because Atlas Roller Chain provides a positive sprocket grip which makes possible the delivery of full rated horsepower without slippage or friction.

This means that your machines can run at full rated speeds and give greater output . . . with Atlas on the drive.

LESS MAINTENANCE

Here's why: The bushings and pins are case hardened by the Atlas Nicarb Process which provides greater inherent strength. Link plates and rollers are also made of tough, heat-treated alloy steel.

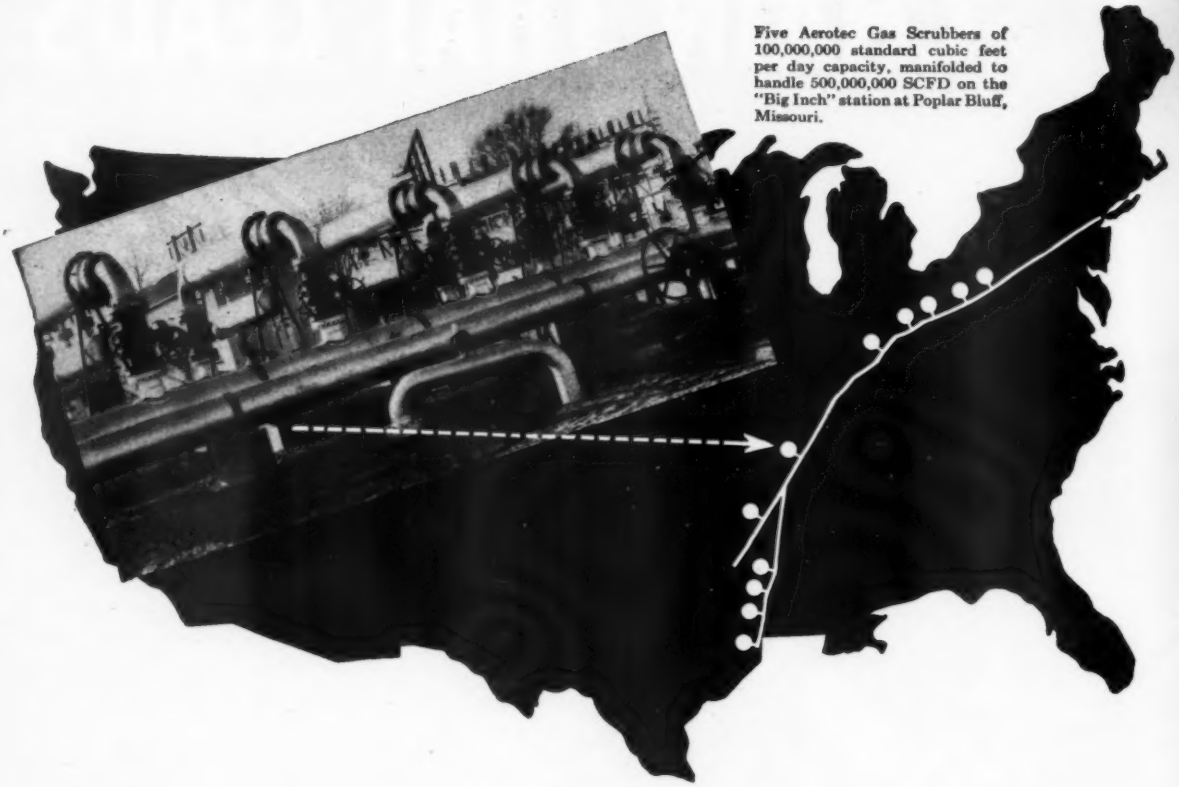
This means better chain performance . . . less chain maintenance.

For maximum production plus long, trouble-free service, install Atlas Roller Chain! Write today for the new Atlas Catalog and Handbook No. 51-OG.

ATLAS CHAIN & MANUFACTURING CO.
PHILADELPHIA 24, PENNA.

ATLAS

ATLAS ROLLER CHAIN



Five Aerotec Gas Scrubbers of 100,000,000 standard cubic feet per day capacity, manifolded to handle 500,000,000 SCFD on the "Big Inch" station at Poplar Bluff, Missouri.

THE INDUSTRY SPECIFIES:

AEROTEC *Dry* GAS SCRUBBERS

On the "Big Inch" pipeline and at the wells, Aerotec Gas Scrubbers are performing with unparalleled efficiency the job of keeping pipelines free of dust, liquid and distillates.

Based on a dry process of separating foreign material from gas, the Aerotec method eliminates the need for a cleaning medium, insures a minimum carryover of foreign matter into the gas stream. Units are available in practically any size up to 100,000,000 SCFD. Larger capacities may be handled by manifolding these standard units to any desired capacity.

Acceptance of Aerotec Gas Scrubbers is best demonstrated by the rapidly growing list of new users. Repeat orders prove that the Aerotec method is setting a new standard for an industry where maximum efficiency is required.

Complete information on this new method is now available.
Write for Catalog 501-2W today!

Project and Sales Engineers

THE THERMIX CORPORATION

Greenwich, Connecticut

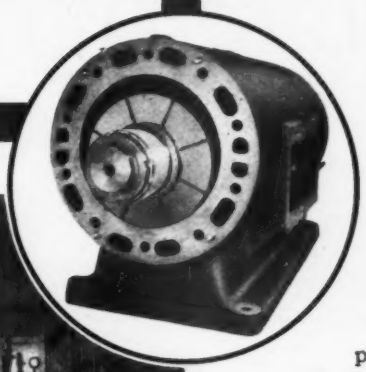
(Offices in 28 Principal Cities)

Canadian Affiliates: T. C. CHOWN, LTD., 1440 St. Catherine St., W., Montreal 25, Quebec

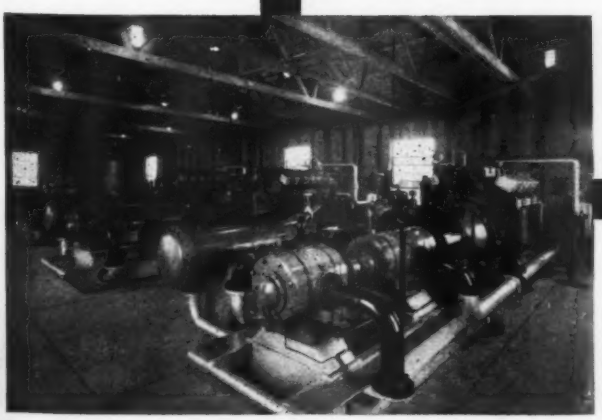
THE AEROTEC CORPORATION

GREENWICH, CONN.

gas gets a better boost



when FULLER gets in the picture



Consider Fuller Rotary Compressors in the over-all picture of your operations. In booster work, whether for field boosting or to trunk line levels, you'll find these compressors doing a better job . . . better because they reduce maintenance cost, cut inspection time, last longer, do the job efficiently.

Pulsing and vibration, valves and complicated parts are eliminated by multi-vane rotary construction. Moving parts are few . . rotor, blades, and bearings. Blades automatically compensate for wear, *maintaining full capacity for the life of the machine.* These features explain why Fuller boosters do an outstanding job wherever gas is handled.

If you're interested in getting maximum efficiency and economy into your operational picture, call on a Fuller Engineer. Bulletin C-5 contains a detailed description of Fuller Rotary Compressors. Write for your copy today.

FULLER COMPANY, Catasauqua, Pa.
120 So. LaSalle St., Chicago 3
420 Chancery Bldg., San Francisco 4

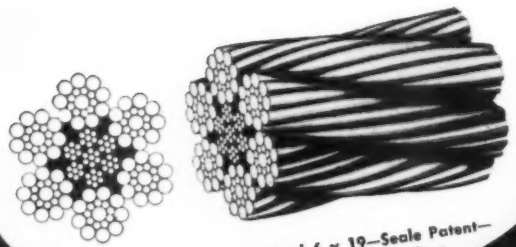
Fuller

DRY MATERIAL CONVEYING SYSTEMS AND COOLERS—
COMPRESSORS AND VACUUM PUMPS—
FEEDERS, AND ASSOCIATED EQUIPMENT

C-210

"American Tiger Brand

BEST SERVICE



American Tiger Brand 6 x 19—Seale Patent—
7 x 7 Independent Wire Rope Core.

WHAT'S THE BEST ROTARY DRILLING LINE? Contractors like Tiger Brand 6 x 19 Seale Patent Monitor Excellay Preformed IWRC. It gives most ton-miles of service per dollar of wire rope cost. Photo shows Clif Tomberlin, driller for Fleet Drilling Company on rig No. 2.

Wire Lines GIVE US THE

OF ANY WE HAVE EVER USED"

says Clif Tomberlin, Driller for Fleet Drilling Company

● The Fleet Drilling Company, at Ada, Oklahoma, operates 17 rigs and has had plenty of experience with various kinds of wire lines. The rotary drilling line they like best is American Tiger Brand 6 x 19 Monitor Improved Plow Steel Excellay Preformed with Independent Wire Rope Core.

The driller on the No. 2 rig, Clif Tomberlin, said "American Wire Lines give us the best service of any we have ever used." The line on the rig had already drilled one well and they were drilling at 6500 feet when these photographs were taken. The original lubrication was still good and the rope was in A-1 condition.

This particular line, Tiger Brand 6 x 19 Seale Patent with Independent Wire Rope Core has become most popular in the oil fields. It has just the right combination of strength, flexibility, fatigue resistance and abrasion resistance to give longest service at least cost. It also has superior resistance to crushing which is especially important on deep wells.

Tiger Brand Wire Lines are made for every oil field use—drilling, well servicing, pipe-line laying or what have you. Send the coupon for our handbooks giving complete information.

AMERICAN STEEL & WIRE COMPANY, GENERAL OFFICES: CLEVELAND, OHIO
COLUMBIA STEEL COMPANY, SAN FRANCISCO
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

TIGER BRAND WIRE LINES on Fleet Drilling Company Rig No. 2. These lines have already drilled one well and the original "Tiger Lube" put in at the factory is still in good condition. This lubrication does not throw off in hot weather or get too stiff in cold weather.

SEND FOR THESE BOOKLETS

American Steel & Wire Company
Rockefeller Building, Dept. P-3
Cleveland 13, Ohio

Please send me:

☐ "American Tiger Brand Lines for Oil, Gas and Water Wells."

☐ "Valuable facts about the use and care of Wire Rope."

Name .....

Company .....

Address .....

City ..... State.....

AMERICAN TIGER BRAND WIRE ROPE

Excellay Preformed

UNITED STATES STEEL

KAYLO HEAT INSULATION

...Easy to Handle and Apply

Kaylo Heat Insulation is easy to handle and apply—in all sizes, shapes and thicknesses—because of its high structural strength and light weight. This remarkable combination of high strength and light weight makes possible speedier application. It provides for units of greater size which permit larger surfaces to be covered faster. With these combined features, Kaylo Heat Insulation gives exceptional ease of handling—offers substantial savings in application costs.

Kaylo Heat Insulation is a hydrous calcium silicate (not glass) with a wide effective temperature range—up to 1200°F. It is inorganic and insoluble in water, incombustible and retains its dimensional stability in long service under severe conditions.

KAYLO PIPE INSULATION is made to Simplified Dimensional Standards of thicknesses and diameters. Coverings are sectional for tube and pipe sizes ¼″ to 12″; tri-segmental up to 23″; quad-segmental up to 41″; K-segmental (18″ wide segments) up to 72″ in diameter.

KAYLO HEAT INSULATING BLOCK is made in all standard sizes and thicknesses from 1″ to 6″ for flat surfaces and for vessels larger than 60′ in diameter; curved block 18″ wide for smaller vessels.

SEE OUR CATALOG IN THE REFINERY CATALOG

For complete details on Kaylo Heat Insulation, write Dept. N-160, Owens-Illinois Glass Company, Kaylo Division, Toledo 1, Ohio.

KAYLO® ...*first in calcium silicate*

...*pioneered by* OWENS ILLINOIS Glass Company

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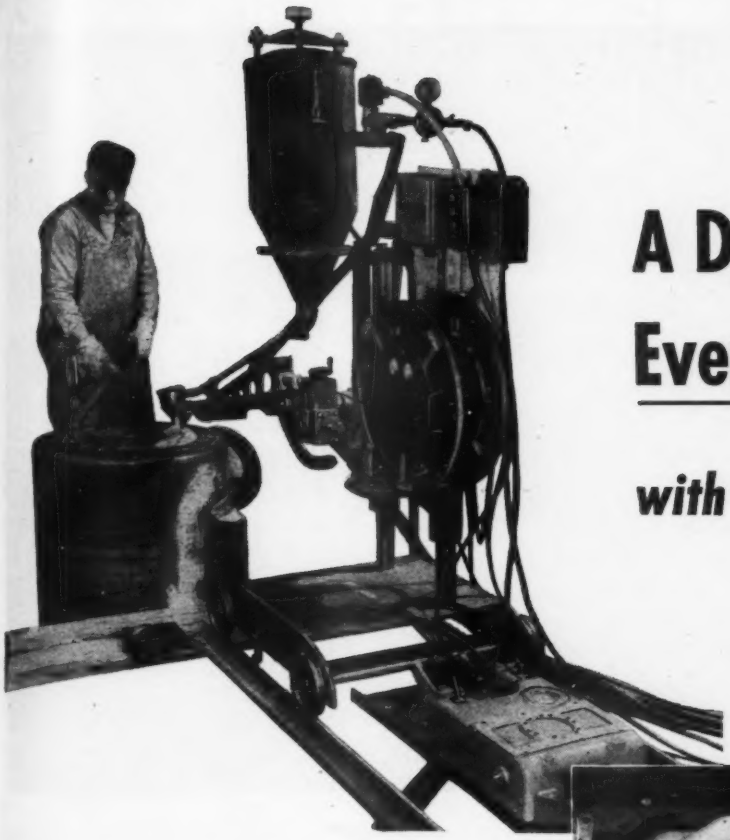


A Day's Output Every Hour

with UNIONMELT Welding

Trade-Mark

(*Above*) UNIONMELT welding a chromium alloy end ring to a mild steel pump shell takes only 1 hour and 23 minutes. Former methods of welding took 10 hours. Ring and shell, each 4 in. thick, are joined in consecutive passes as the work rotates under the UNIONMELT welding head.

(*Right*) This UNIONMELT welding machine smoothly deposits a sound, corrosion-resistant overlay inside a mild steel pump shell. Stainless steel metal — 20 to 120 lb. of it, depending on pump size — builds up at 20 lb. per hour. Highest former rate was 2 lb. per hour.

In making high-pressure steam pumps, these two welding operations used to take 20 hours—2½ working days. This was cut to 2½ hours by UNIONMELT welding as shown above. In addition, finishing costs dropped sharply because the UNIONMELT deposits are smoother and need less machining.

High-speed production is common wherever automatic UNIONMELT welding is used to join ferrous or non-ferrous metals. Welds up to 3 in. thick can be made in one pass; light-gage sheet can be welded at speeds up to 200 in. per minute.

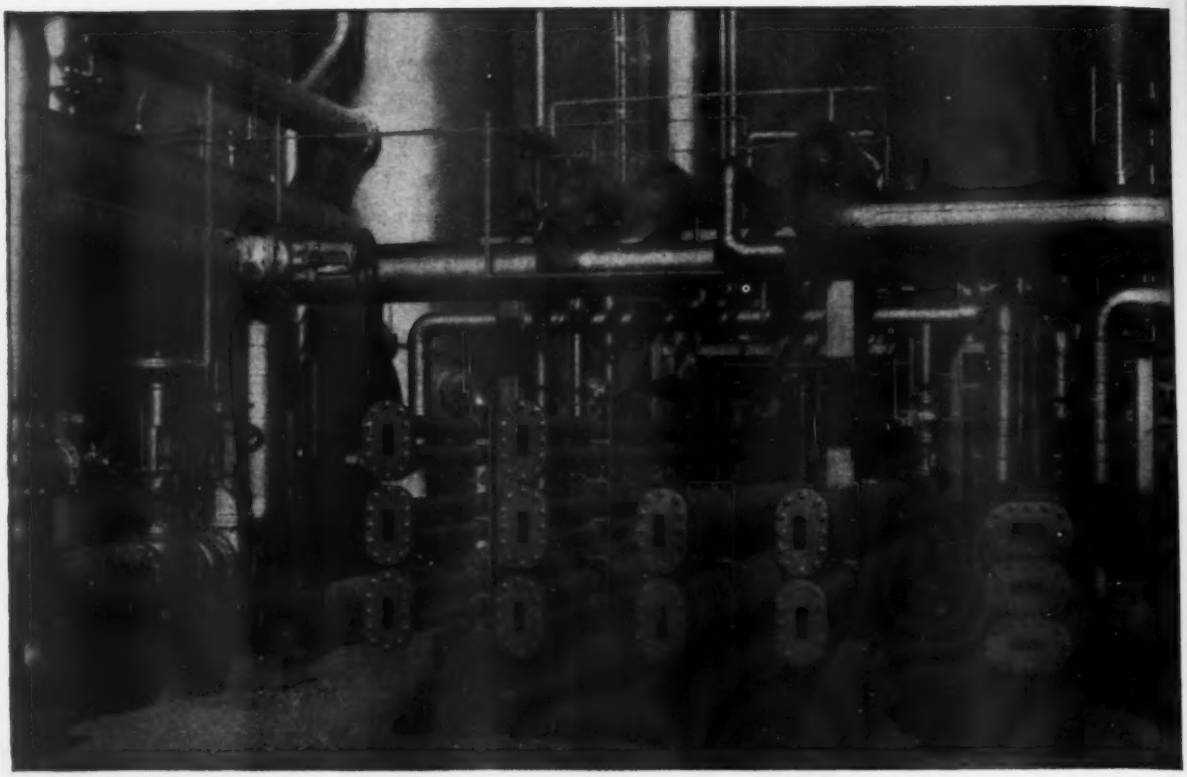
UNIONMELT welding is only one of many time- and moneysaving LINDE methods for making, cutting, joining, treating, and forming metals. So, whatever you do with metals, there is a good chance that LINDE know-how, show-how, and equipment can help you do it better, more quickly, or at lower cost. Telephone or write to our nearest office today. LINDE AIR PRODUCTS COMPANY, a Division of Union Carbide and Carbon Corporation, 30 East 42nd Street, New York 17, N. Y. Offices in Other Principal Cities. In Canada: Dominion Oxygen Company, Limited, Toronto.

Unionmelt

Trade-Mark

EQUIPMENT AND SUPPLIES
for fast, automatic electric welding.
No sparks, spatter, smoke, or flash.

The terms "Linde" and "Unionmelt" are registered trade-marks of Union Carbide and Carbon Corporation.



use BROWN FINTUBE *Sectional Hairpin* HEAT EXCHANGERS *as*

- HEATERS
- COOLERS
- HEAT EXCHANGERS
- CONDENSERS
- GAS COOLERS
- REBOILERS
- FUEL OIL HEATERS
- LUBE OIL HEATERS AND COOLERS
- JACKET WATER COOLERS
- QUENCH OIL COOLERS
- COMPRESSOR INNER AND AFTER COOLERS

● These exchangers combine the repeatedly demonstrated advantages of Brown's exclusive integral "one-piece" fintubes that assure high heat transfer efficiency; and Brown's ring joint head end seal that is easily dissembled for cleaning, and reassembles tightly, preventing leakage. Furnished with fintubes of mild steel, stainless steel, monel, inconel, aluminum, admiralty or other non-ferrous metals to suit any requirement. Widely used — and highly endorsed by engineers, operators and maintenance men everywhere.

Write for Bulletin No. 481. It gives full details.

THE BROWN FINTUBE CO.
ELYRIA, OHIO

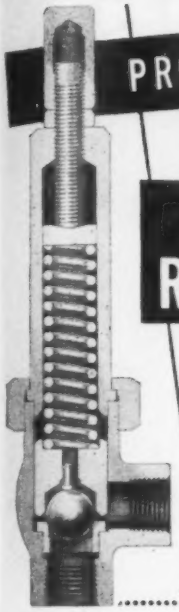
SECTIONAL HAIRPIN HEAT EXCHANGERS

Specify these Edward Steel Valves . . . from the Line that Gives You the Better Designs

PROTECT EQUIPMENT

against abnormal pressure increases with

Edward RELIEF VALVES



Edward relief valves protect equipment against sudden and unusual pressure increases in piping systems. Foolproof design and accurate spring action make them absolutely dependable. One low cost valve can save much expensive equipment.

Used extensively in power, chemical, process, petroleum, hydraulic, marine, and general industrial service, they are particularly suited for relieving pressure in pump lines, drums, heat exchangers, and unfired pressure vessels handling water, steam, oil, or vapor.

They need no packing, maintenance is negligible, and the fine pitch threads of the adjusting screw allow close regulation of pressure setting.

NEW BULLETIN Write for new free bulletin No. 711 containing latest design details, dimensions, weights, and installation information.

Edward PRESENTS New ALL-PURPOSE STEEL VALVES

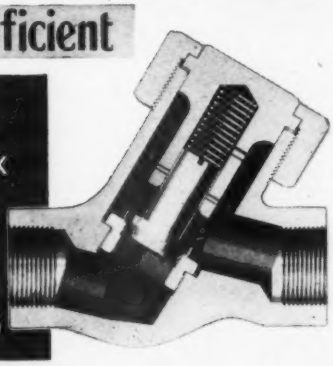
A new all-purpose valve series, ideal for almost any service where small O. S. & Y. steel valves are used. Drop forged steel for greatest strength . . . simplest packing arrangement . . . tight, easily accessible union or bolted bonnet joints . . . bronze yoke bushings . . . microscopically mated seats and disks . . . lock welded parts. Built in sizes ¼ to 2 in. inclusive, globe or angle, screwed or socket welding ends, carbon or chromium molybdenum steels, in 600 or 1500 lb sp classes. Stocks now available.

Bolted bonnet 1-¼ in. up 600 lb, 1 in. up 1500 lb. Union bonnet in smaller sizes.

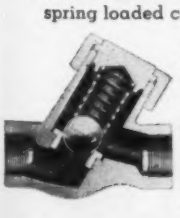
For full details, dimensions, illustrations write today for your free copy of . . . . **BULLETIN 501**

Quiet . . . Efficient

Edward NON-SHOCK Ball & Piston CHECK VALVES

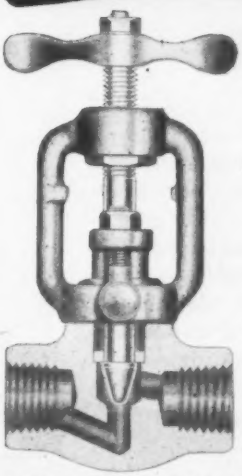


Vibration, clatter, and damaging shock to piping are cut to a minimum with Edward forged steel ball and piston check valves. Cushioned closing action eliminates excessive vibration. Accurate guiding and spring loaded construction assure fast positive seating. EValloy stainless steel seat and ball or piston give maximum trouble-free service.



Union or bolted bonnet in sizes ¼ in. to 2 in. inclusive in two pressure classes —600 lb at 850 F and 1500 lb at 850 F. For complete information, write for Catalog 104.

PRECISION REGULATION Edward Instrument Valves



New Edward Fig. 952 series instrument valves, so compact they fit limited spaces in such hook-ups as panel boards and manifolds, give precision regulation for meter, gage, regulator, by-pass and instrument lines of all types. Forged steel, globe or angle. Rated 6000 lb WOG, 1500 lb 850 F in carbon steel. Also in stainless steels with higher ratings.

- No bonnet joint to leak.
- Swing bolted gland for easy packing.
- Needle point stem, fine pitch threads for accurate regulation.

WRITE FOR NEW BULLETIN Bulletin 491, with full details, is yours for the asking.

EDWARD BUILDS Globe and Angle Stop Valves • Integral Bonnet Univalves • Gate Valves • Non-Return Valves • Blow-Off Valves • Feed Line Stop-Check Valves • Intex (Integral Seat) Valves • Instrument Valves • Check Valves • Relief Valves • Hydraulic Valves • Gage Valves • Strainers • Special Designs

Edward Valves, Inc.

SUBSIDIARY OF ROCKWELL MANUFACTURING CO.

EAST CHICAGO, INDIANA

321 STAINLESS

An Assured Supply Lower Cost Technical DATA*

*The assurance of a continuous supply of Titanium to make stabilized austenitic chromium nickel steel...plus the economic advantage of the lower price of type 321 has focused increasing attention on its other outstanding features. Among these are excellent high temperature properties, thermal shock resistance and ease of drawing and forming.

In the "as-welded" state, as normally used, 321 shows a high order of corrosion resistance in a variety of corrosive media. It is being used effectively in many installations with type 347 weld rods used in welding.

* In developing the Low Carbon Ferro Titanium alloys used in making 321 stainless, TAM has acquired much worthwhile technical data. Therefore, although we do not supply steel, we can supply you with information of value. Write our New York City Office.

TAM PRODUCTS
Registered U. S. Pat. Off.

*TAM is a registered trademark.

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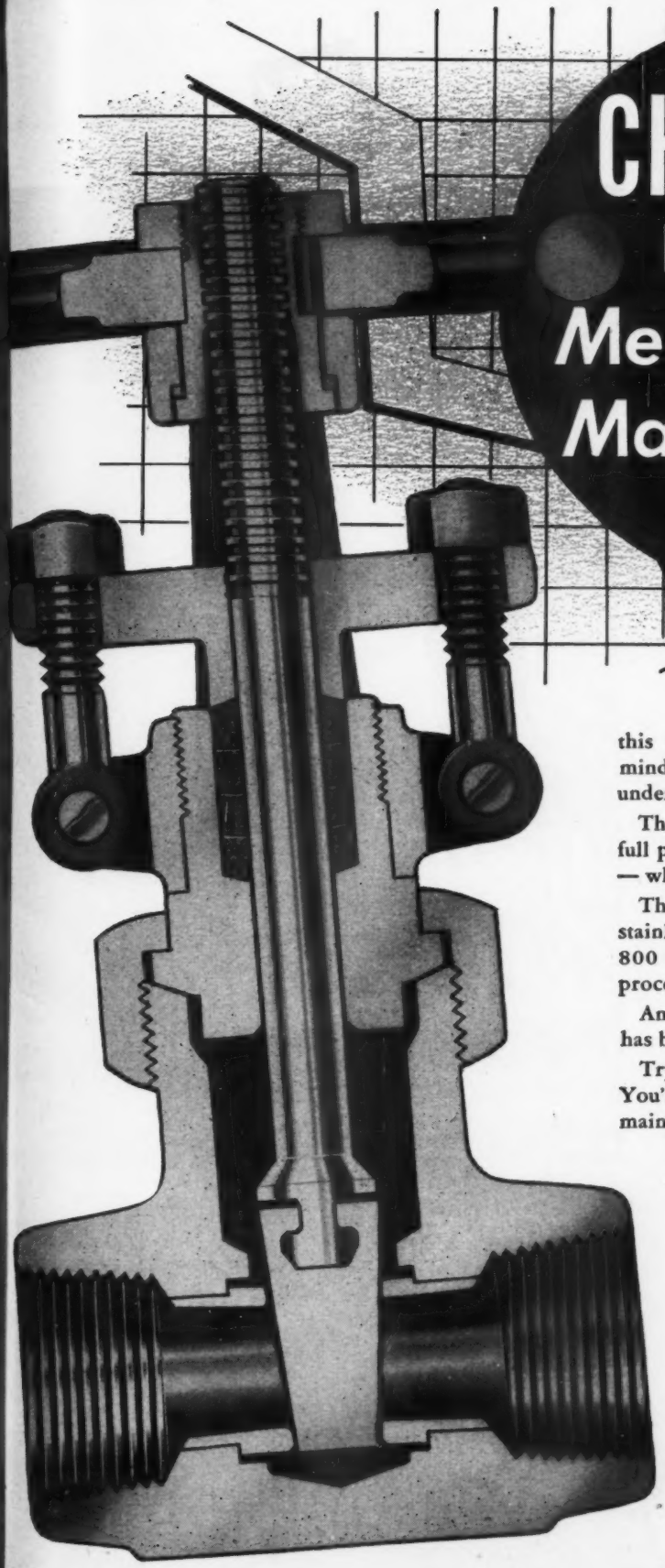


CHAPMAN LIST 960 *Means Lower Maintenance Costs*

Chapman engineers designed this valve with your maintenance problem in mind. They've made it *tough,* so it will stand up under severest service — but *easy* to maintain.

That's why you can repack this List 960 under full pressure. Seat rings replaced quickly, easily — when necessary.

The reason, too, why seat rings are hardened stainless steel and wedge faces are hardened to 800 Brinell by the exclusive Malcomizing process.

And why the stem and wedge gate connection has been made 50% stronger than ever before.

Try it! Make your own maintenance checks. You'll find the Chapman List 960 means lower maintenance costs.

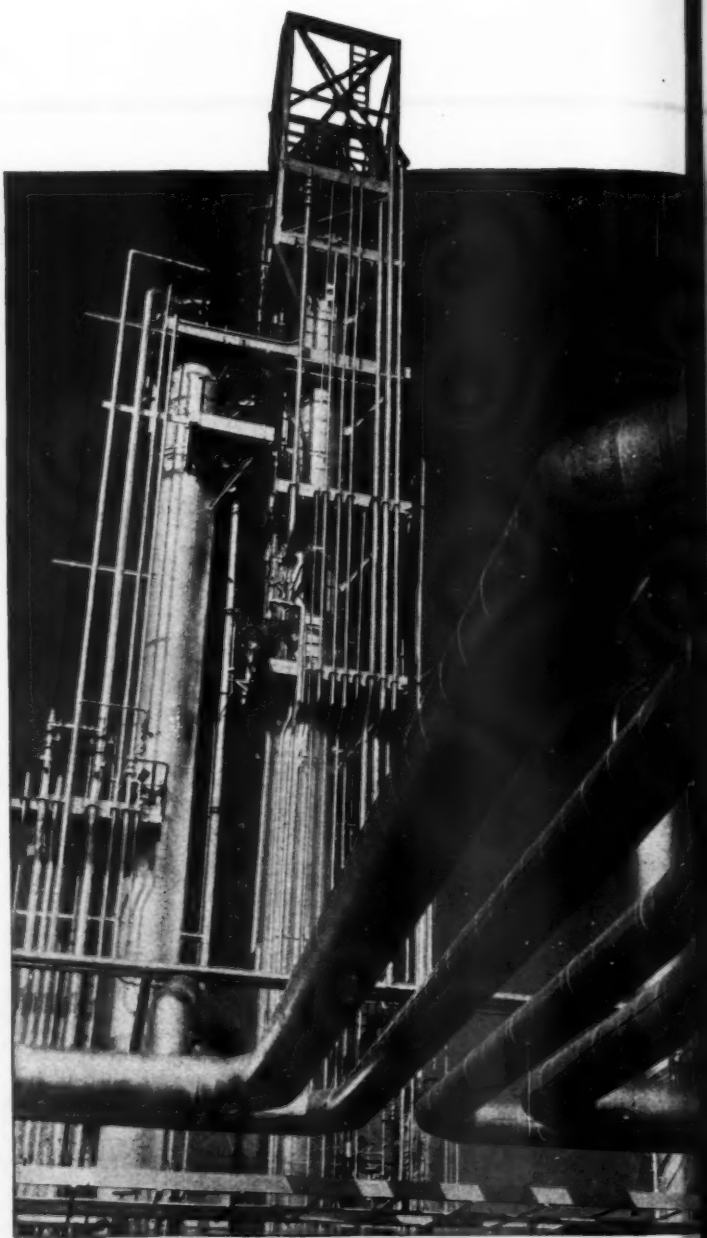
Available in sizes from ¼" to 2". Either metal to metal or gasketed joint, as required. Rising stem with yoke (as illustrated) or rising stem inside screw type. For pressure range 2000 lbs. at 100 deg. F., 380 lbs. at 1000 deg. F. Specify List 990 for higher pressures.

The Chapman Valve Manufacturing Company

INDIAN ORCHARD, MASSACHUSETTS

YOU CAN BE **SURE**.. IF IT'S

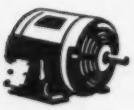
Westinghouse



Turbines

Turbo Generators

Ignitron Rectifiers



A. C. Motors

Gear Motors

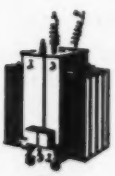
Speed Reducers

Corrosion Resisting Motor Control

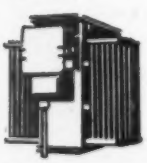
Circuit Breakers for Hazardous Locations

Disconnecting Switches

Instruments



Power Transformers



Distribution Transformers and Switchgear

Capacitors

Industrial Lighting

Electronic Tubes

Oil Immersed Pushbuttons

Oil Im... Panel...

Westinghouse

EQUIPMENT FOR THE PETROLEUM INDUSTRY

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Unit Responsibility

CUTS REFINERY POWER COSTS

The manufacturer of your power generating and distribution equipment can play a vital role in providing the most efficient power system for your refining and petrochemical processes. In serving you, that manufacturer should be capable of:

1. Providing the complete line of power equipment your process may require.
2. Furnishing you co-ordinated engineering and supervision of installation.
3. Giving you the benefit of years of experience in the application of power equipment in the Petroleum Industry.

These elements of unit responsibility add up to a reduction in costs. You get them all from Westinghouse.

GENERATION: Westinghouse gives you the complete installation for producing power, plus help in working out your electrical and steam requirements for most efficient plant balance.

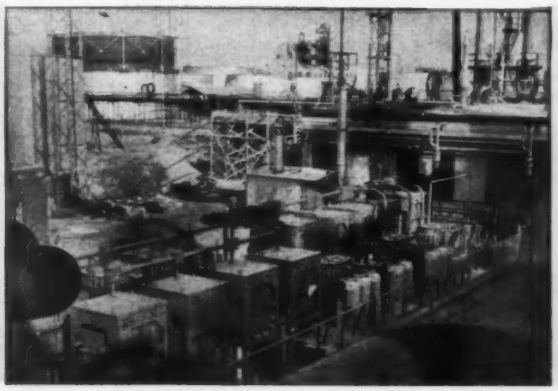
DISTRIBUTION: Westinghouse makes a correlated line of distribution apparatus, ranging from the smallest arrester to the world's largest substation. All indoor and outdoor enclosures are Bonderized to resist corrosion, and outdoor switchgear is additionally protected by all-weather undersurface coating.

UTILIZATION: Westinghouse makes a full line of mechanical drive turbines and oil refinery motors, ranging from small, explosion-proof, fan-cooled, Life-Line motors to the largest explosion-resisting, inert-gas-filled, squirrel-cage type motors ever built. A complete line of Westinghouse controls, including corrosion-proof or explosion-proof types where needed, is also available to meet the rigid requirements of refinery service.

Give us an opportunity to assume this unit responsibility and help you find the solution to your refinery power problems. Call your nearest Westinghouse office, or write to Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa.

J-94803

This Westinghouse 7500-kva turbogenerator is installed in a large refinery power plant. Where utility power is not available in sufficient quantities for a large refinery, units of this type provide an economical source of power.

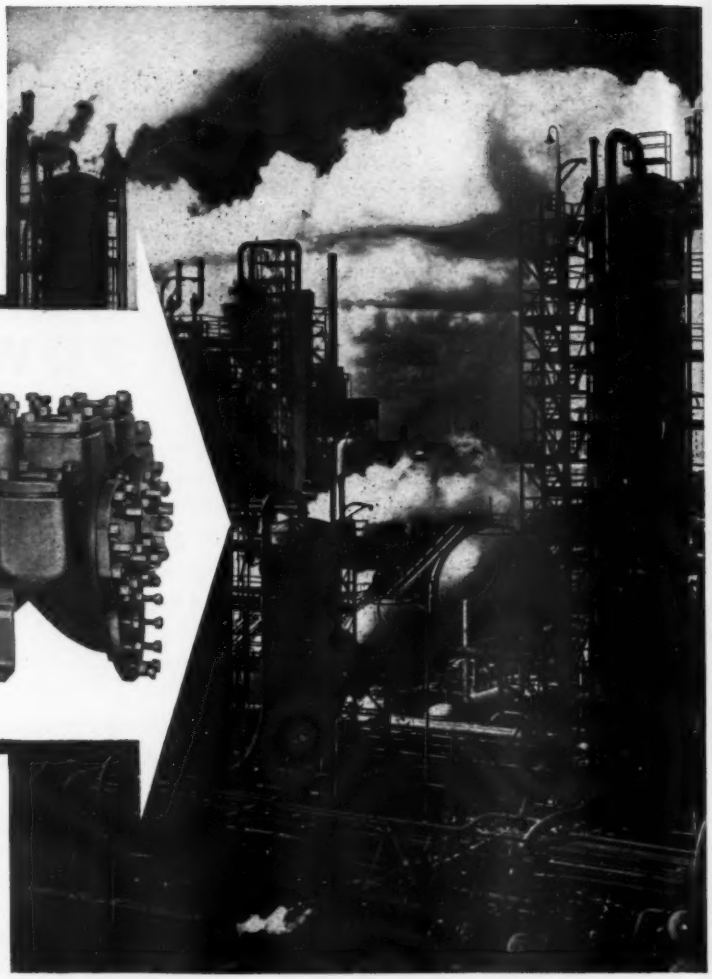


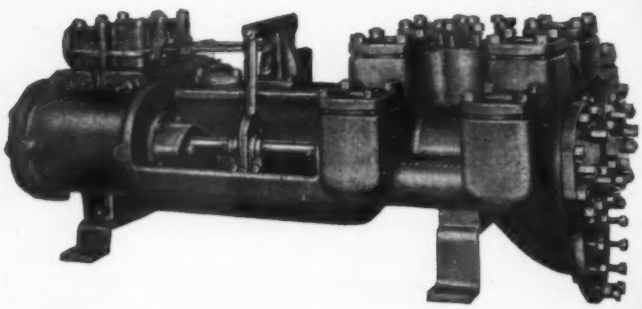
The use of Westinghouse oil-immersed equipment suitable for hazardous and corrosive atmospheres made it possible to locate this motor control and distribution center near the loads, thus reducing length of individual circuit runs.

XUM

Right...

WHERE IT BELONGS!





The Worthington Horizontal Duplex Side Pot Pump is Designed Especially For Refinery Service

Ever since the first refinery started, Worthington has been custom-designing pumps for petroleum processing, giving full consideration to every factor — viscosity, vapor pressure, entrained gas, suction conditions, etc. — that enters into refinery pumping requirements. You see a typical result of this long, specialized experience in the Worthington Type PRL, a horizontal duplex side pot steam pump, a top performer in refineries the country over.

Ready For Action

Normally built for cold oil service, the Type PRL comes to you thoroughly equipped for the job. There are no costly "extras" to buy . . . because such essential features as "NiResist" liquid cylinder liners, stainless steel liquid piston rods and valves, lantern glands and extra deep stuffing boxes are all standard. Where required, Worthington cup pistons and packing, and "Rollo" semi-spherical valves are available. For hot oil service, the PRL can be equipped with cast steel liquid cylinders, water jackets, and wing valves.

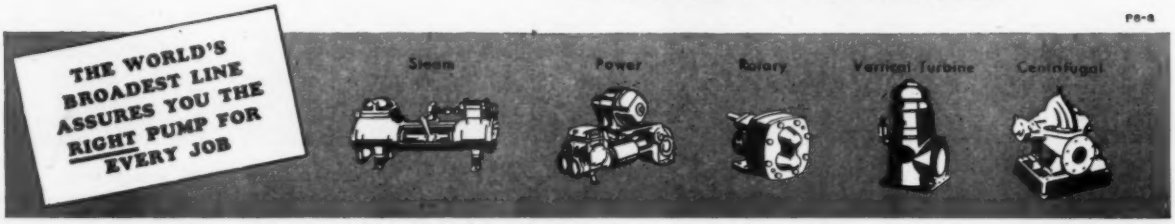
Built To Last

As durable as it looks, the PRL is rugged inside and out, with every part designed to give you the years of money-saving, trouble-free experience that proves *there's more worth in Worthington.* Get further facts, about this specialized pump. Write to *Worthington Pump and Machinery Corporation, Reciprocating Pump Division, Harrison, New Jersey.*

WORTHINGTON

PR-4

THE WORLD'S BROADEST LINE ASSURES YOU THE RIGHT PUMP FOR EVERY JOB



No bogging down or stalling on soft or slippery surfaces!

WALTER 100% TRACTION gets to any location — fast!

WHERE conventional trucks slip and stall on mud, soft dirt, sand, snow or grades—Walter Tractor Trucks continue hauling smoothly and steadily. The Walter Four Point Positive Drive, with automatic locking and torque proportioning differentials, eliminates spinning wheels and provides constantly available tractive power in four driving wheels. All units on this page incorporate the exclusive Walter drive system, plus many other valuable features for oilfield service.

NEW WALTER OILFIELD TRACTOR. Fast, compact, highly mobile carrier for servicing equipment.

Hauls drilling, servicing and exploratory equipment to off-highway locations formerly impossible with wheeled vehicles. Travels 30 to 40 m.p.h. on normal roadways. Heavy-duty 125 h.p. motor; 90 inch wheelbase; large, single 14.00 x 20 tires; 16 inch ground clearance. Exerts 12,000 lbs. tractive effort at 3 m.p.h. Total gross weight of 16,000 lbs. Larger models also available.

WALTER TRACTOR TRUCKS for heavy duty hauling

Powerful, 100% traction, 240 h.p. tractor for trailer-hauling 20 to 25 ton payloads of rigs, pipe or heavy equipment to toughest locations. Combined with properly designed trailers, will haul 70,000-80,000 lb. gross train weights within legal highway axle loading and width limitations. Rugged construction, easy handling and maneuvering.

WALTER FIRE FIGHTER for oil and gasoline fires

A completely self-contained, high-capacity, mobile "fire extinguisher" which discharges a total of 4,800 gal. of fire-sealing Fog-Foam per minute by means of two turret jets, three ground-sweeping jets and three hand-line jets. Accelerates to 45 m.p.h. in one minute—100% traction keeps going through any running conditions.

For complete details, see your nearest distributor—or write

WALTER MOTOR TRUCK CO., 1001-19 Irving Ave., Ridgewood 27, Queens, L. I., N. Y.

WALTER
4-POINT POSITIVE DRIVE
TRACTOR TRUCKS

See your nearest distributor

EAST
J. F. Brittain
2001 Glenwood Park Ave., Erie, Pa.
Clyde W. Beckner, Inc.
219 Virginia St., W., Charlestown, W. Va.

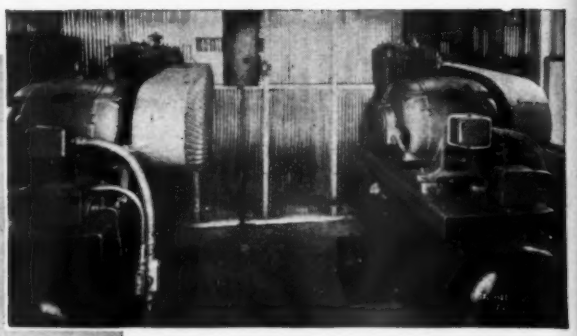
MONT., WYO., NEW MEXICO
Gamble Equipment Co.
3245 Larimer St., Denver, Colo.

TEXAS
Plains Machinery Co.
P. O. Box 288, Amarillo, Tex.

CALIFORNIA
Edward R. Bacon Co.
17th & Folsom St., San Francisco

OKLAHOMA, ARKANSAS
Diesel Power Company
1801 N.E. 9th St., Oklahoma City, Okla.

LOUISIANA and MISSISSIPPI
Logan Perkins
Int'l Trade Mart, New Orleans, La.



Above—Two 10 horsepower Century squirrel cage motors driving air compressors.

At left—7½ horsepower Century splash proof motor driving a pumping unit.

Century MOTORS for the Oil Industry

Assure Dependable, Economical Operation

Subjected to rain, snow, sleet and hail thousands of Century Splash Proof Type SCT High Torque High Slip Motors are operating producers' pumps—many for 18 years.

The high slip of the Century type SCT motor saves wear and tear on equipment because it slows down and cushions the impact of the peak load and reduces the sudden shock and its damaging effect.

Century builds a wide range of electric motors, in sizes from 1/6 to 400 horsepower, for oil producing and refining operations. Popular types and standard ratings are generally available from factory and branch office stocks.

Specify Century motors for all your electric power requirements. See your regular supply store.

Illustrating Century splash proof and explosion proof motors.

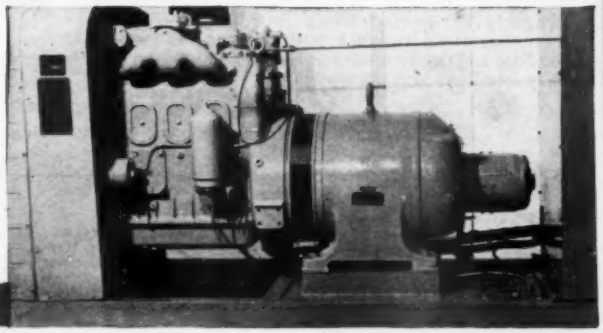
CENTURY ELECTRIC CO.
1806 Pine Street • Saint Louis 3, Missouri
Offices and Stock Points in Principal Cities

-620

Century C MOTORS

Century Type ARC Generator

Where public service current is not available, Century Generators will provide adequate, continuous electric power. Depending on the load per motor and the size of generator, from 10 to 30 wells can be operated from one generator. They provide a dependable source of oil field power.



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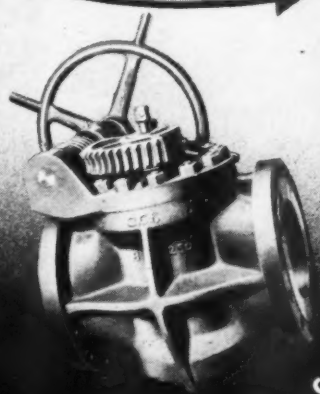
UNINTERRUPTED FULL FLOW

FULL PIPE AREA CYLINDRICAL PLUG...

Stands alone in its ability to minimize turbulence and change of velocity, without use of larger-than-pipe-size valves. Quick operation, if needed, no wedging, lubricated for long life and corrosion protection...why anything but an a.c.f. Lubricated Plug Valve.



CYLINDRICAL FULL PIPE AREA LUBRICATED

a.c.f. PLUG VALVES

Representatives in more than 50 Principal Cities.

a.c.f. Valves are available in many types and sizes. Ask for catalog 4-OG. American Car and Foundry Company, 1501 E. Ferry Ave., Detroit 11, Mich.

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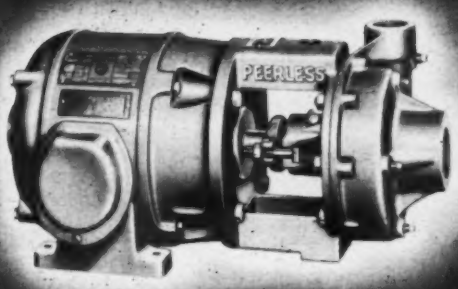
DURABLE • ECONOMICAL • EFFICIENT PUMPS FOR USE IN MOVING OR TRANSFERRING LIQUIDS

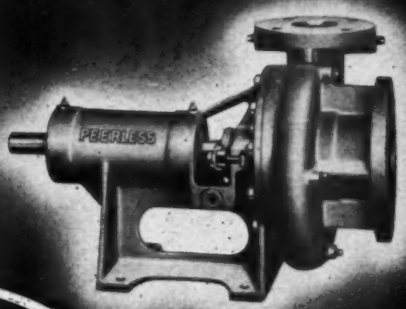
THE PEERLESS *Fluidyne* LINE

CLOSE-COUPLED TYPE
Integral H.P.



Type PE MOTOR SIZE: 1-60 H.P.
CAPACITY: Up to 1000 gpm
HEADS: Up to 200 Feet

BELTED OR DIRECT-CONNECTED TYPE *Integral H.P.*



Type PB MOTOR SIZE: 1-150 H.P.
CAPACITY: Up to 5500 gpm
HEADS: Up to 260 Feet

PEERLESS PUMPS

A COMPLETE LINE OF CLOSE-COUPLED ELECTRIC, BELTED OR FLEXIBLE COUPLED PUMPS FOR GENERAL PURPOSE REFINERY USE

Want compactness? Want efficiency? Want durability? Want economy? You can have them all by using pumps in the versatile and complete line of Peerless Fluidyne pumps.

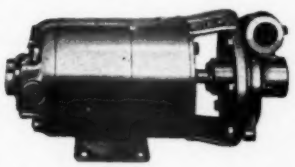
Versatile, because they can be applied to a host of diversified services calling for transferring of liquids.

Complete, because they offer widest range of sizes and models. The Type PE Fluidyne pump, a close-coupled bracket-type pump, is electric drive, available from ¼ to 60 hp. It is close-coupled to standard horizontal pump electric motors. The Type PB is available in sizes up to 150 hp. It differs from the Type PE in that it is built to receive standard V—or flat belt pulleys for engine drive, or it can be mounted on a common base with an electric motor and driven by a flexible coupling.

Both Type PE and Type PB Fluidyne pumps are single stage, end suction, centrifugal design. Simplicity and quality and ruggedness are inherent in their design. All parts are easily accessible. Close attention to hydraulic characteristics has resulted in pumping units of high efficiency, regardless of position in which they are installed —vertical, horizontal, or intermediate angle. Disassembly and assembly for inspection or maintenance is rapid.

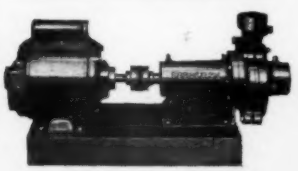
NEW BULLETIN
describes additional features of both fractional and integral hp pumps in the Peerless Fluidyne Line. Write for your copy of this 24-page fully illustrated and descriptive bulletin today.

FRACTIONAL HORSEPOWER CLOSE-COUPLED TYPE PE



¼ to 1½ h.p. • 3450 rpm • 60 cycle
Capacity: To 65 gpm • Heads: To 110 Ft.

FRACTIONAL HORSEPOWER TYPE PB MOUNTED ON COMMON BASE



¼ to 1 h.p. • 3450 rpm • 60 cycle
Capacity: To 50 gpm • Heads: To 90 Ft.

PEERLESS PUMP DIVISION
FOOD MACHINERY AND CHEMICAL CORPORATION
Address Inquiries to Factories at:
Los Angeles 31, California and Indianapolis 8, Indiana
Offices: New York, Atlanta, Fresno, Los Angeles, Chicago, St. Louis, Phoenix; Dallas, Plainview and Lubbock, Texas; Albuquerque, New Mexico

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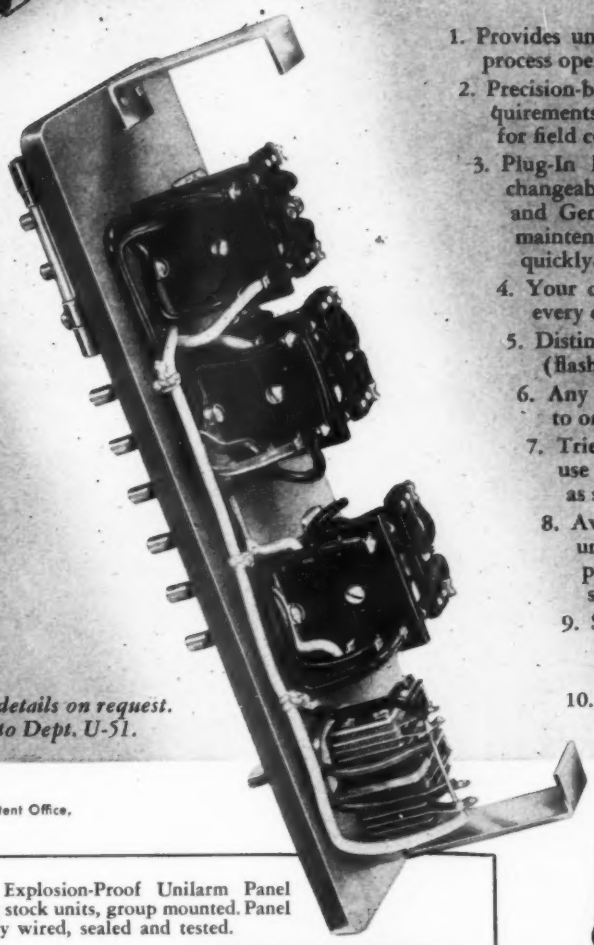
No Other Alarm System Has ALL The Advantages Of

R&S UNILARM*...



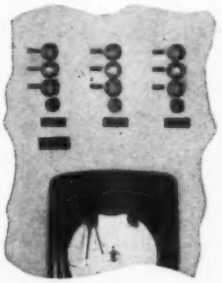
1. Provides unfailing supervision of equipment and process operations.
2. Precision-built to Underwriters' Laboratories requirements. Completely wired and tested . . . ready for field connections.
3. Plug-In Panel (large illustration), fits interchangeably into Explosion-Proof, Vaportight and General Purpose enclosed units. Reduces maintenance to a minimum . . . easily and quickly replaced with a spare unit.
4. Your choice of 100 standard circuits to suit every conceivable application.
5. Distinctive visual signal for each condition (flashing light) insures immediate attention.
6. Any number of Unilarms may be connected to one audible signal.
7. Tried and tested in the field. Thousands in use giving trouble-free protection. Accepted as standard by leading industries.
8. Available as individual unit or in multi-unit Panels. Also time delay types for applications subject to high surge or excessive vibration.
9. Saves space, engineering costs, installation and maintenance over other alarm systems.
10. Acknowledgement-test switch permits periodic testing of each Unilarm circuit.

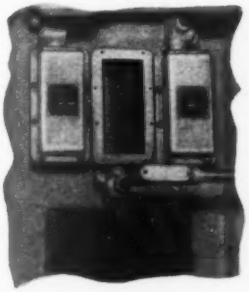
Complete details on request. Write to Dept. U-51.

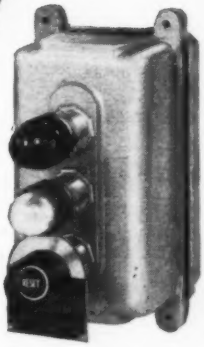
*Reg. U.S. Patent Office.

D1

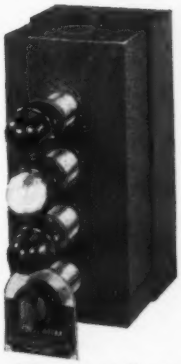
Special Explosion-Proof Unilarm Panel showing stock units, group mounted. Panel is factory wired, sealed and tested.







Vaportight Unilarm



General Purpose Unilarm

R&S Unilarm is also available in a complete line of Surface Mounted Types — Explosion-Proof, Vaportight and General Purpose.

RUSSELL & STOLL

RUSSELL & STOLL COMPANY, INC. • 125 BARCLAY STREET, NEW YORK 7, N. Y.

PRECISION-BUILT ELECTRICAL EQUIPMENT—SINCE 1902

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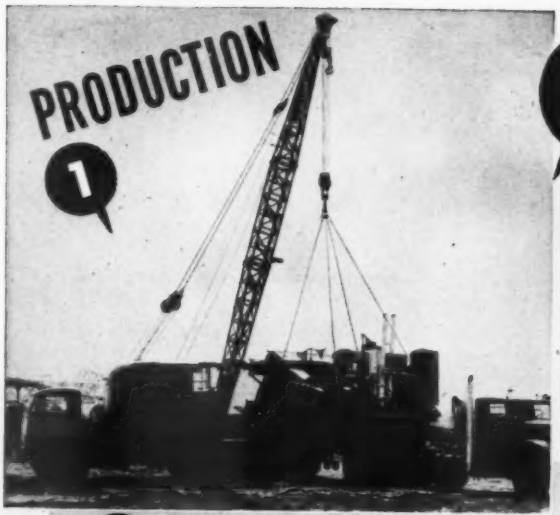


4 SURE CURES for Oilfield Problems

■ Lorains proved to be the *best answers* to these four oilfield problems. They cover just about every phase of operation . . . *drilling, refining, pipelining* and *stringing*. Proving this point . . . Lorain offers *unlimited selection* of capacities, mountings and front end types to meet the many and varied needs of the petroleum industry, for production, refinery and transmission. The Lorain line includes 6 turntable "series" in many capacities, on crawler or rubber-tire mountings, with 5 interchangeable booms for any digging, lifting or material handling need. You can be *sure* a Lorain will pay its way . . . and there's *sure* to be a Lorain to fit your need!

THE THEW SHOVEL CO., LORAIN, OHIO

1 PROBLEM: *Loading a heavy draw works for transportation to field location.* Lacey Trucking Co., Bakersfield, California, owners of 2 Lorains, finds many jobs like this one for their mobile, 30 m.p.h. Lorain Moto-Crane.

2 PROBLEM: *Setting a new condenser in place—removing the old one—at a refinery.* Again, a Lorain Moto-Crane moves in at this Texas refinery and makes fast, easy work of a big lift.

3 PROBLEM: *Digging a trench across a river and going on for miles cross-country.* Oklahoma Contracting Co., Dallas, Texas, owners of 6 Lorains, wades across this river with their crawler-mounted Lorain "Pipeliner Junior" on their 16-inch line between Portland and Montreal.

4 PROBLEM: *Unloading pipe from trucks—feeding stringing crews along the right-of-way.* Dunn Brothers of Dallas, Texas, take advantage of Lorain Moto-Crane mobility—to move quickly all along the line—with plenty of tractive drive to travel the rough spots.

3 FREE FOLDERS . . . FOR OIL MEN!

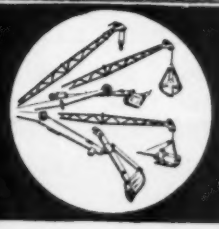
1. Lorains in the Petroleum Industry—showing applications from production to refinery.

2. Lorains on Pipeline Construction—features Lorain "Pipeliners" on nation's biggest spreads.

3. Cost Cutters of the Petroleum Industry—many job saving uses in picture and data.

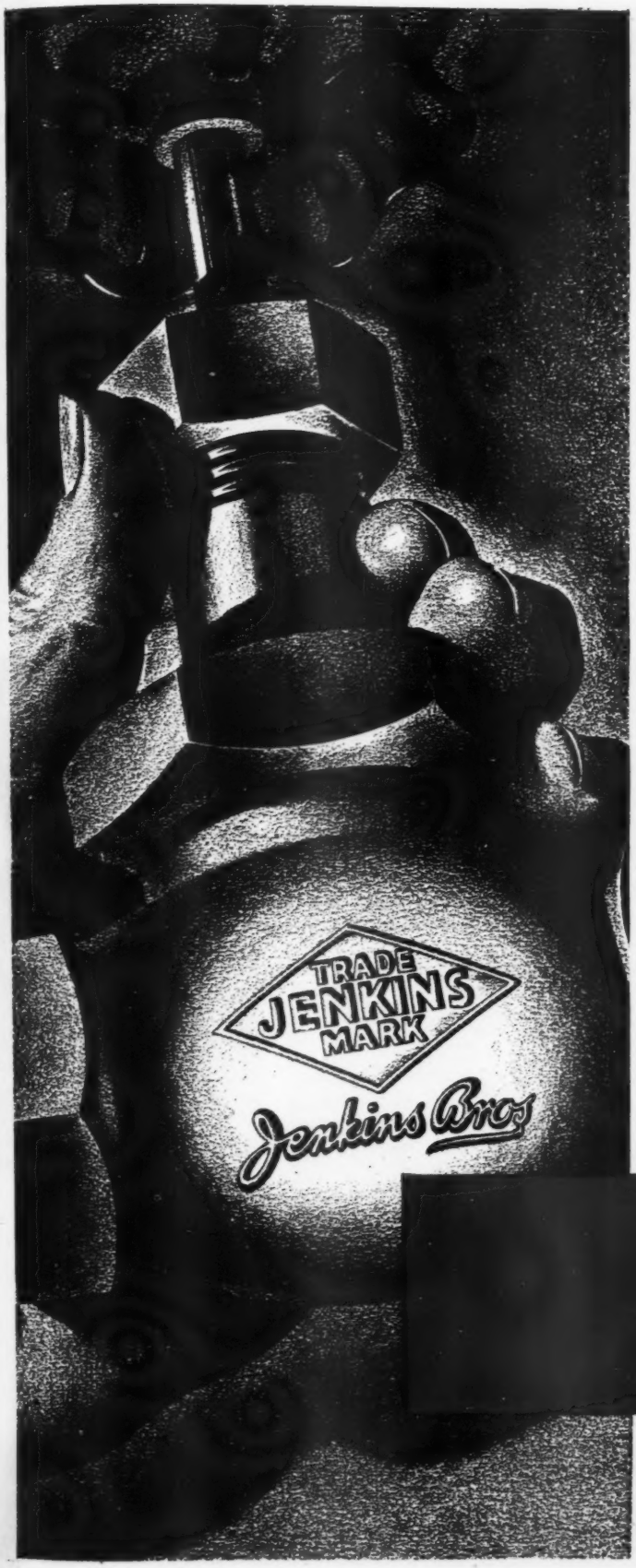
Get copies from your distributor or write Thew Shovel Co.

THEW **LORAIN**® *on CRAWLER or RUBBER*



SHOVELS
CRANES
DRAGLINES
CLAMSHELLS
HOES

XUM



"We will sign it with our name"

Few things in life are as precious to a man as his name. He bestows it with pride on his heirs. He does not sign it lightly. To the man of integrity, his signature is not so much a means of identification as an evidence of good faith.

When the Jenkins brothers were satisfied they had made the best valve money could buy, they *signed* it with their name. Today, as for over three quarters of a century, that signature — forming, with the famous Diamond, the Jenkins trade mark — is more than a symbol of the maker's pride in his craftsmanship. It is the mark of a friend you can trust.

Jenkins Bros., 100 Park Avenue, New York 17. Jenkins Bros., Ltd., Montreal.

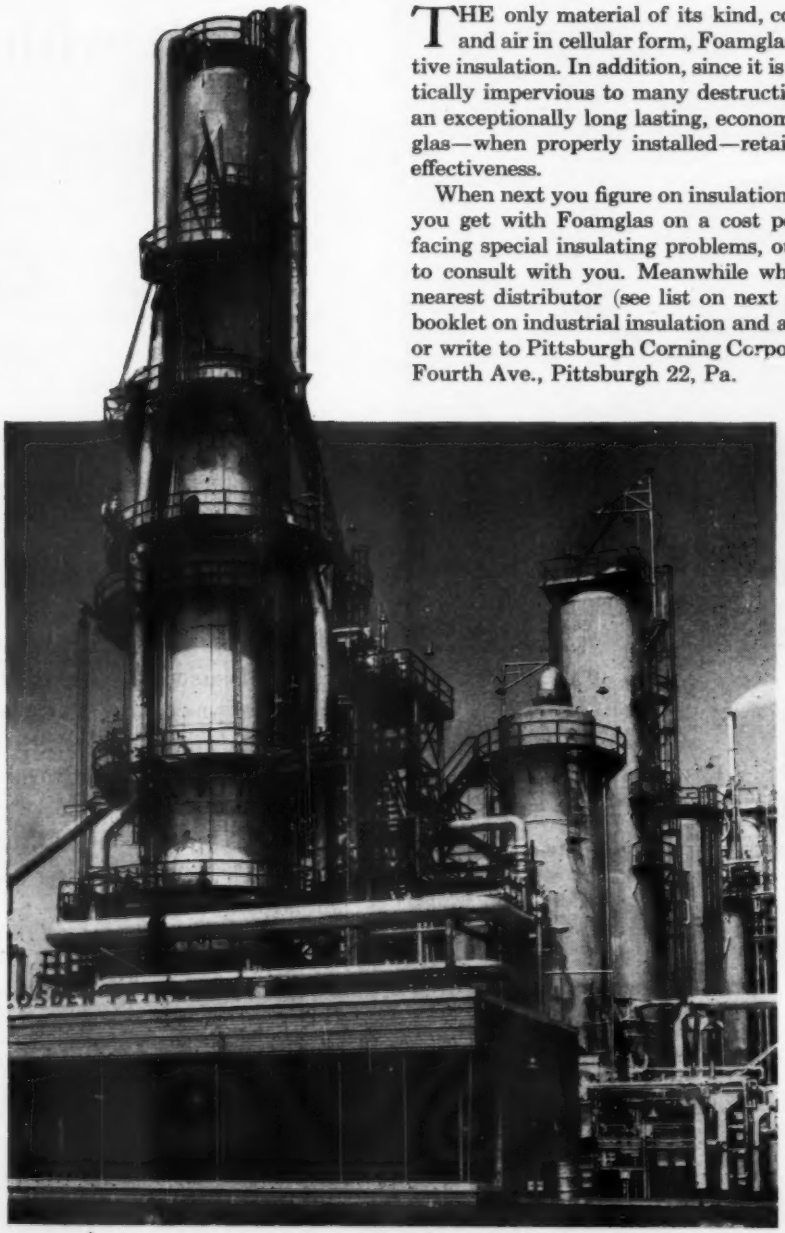
XUM

THE BEST GLASS INSULATION IS CELLULAR GLASS...

the only cellular glass insulation

THE only material of its kind, composed entirely of glass and air in cellular form, Foamglas is an exceptionally effective insulation. In addition, since it is glass, and therefore practically impervious to many destructive elements, Foamglas is an exceptionally long lasting, economical material. PC Foamglas—when properly installed—retains its *original* insulating effectiveness.

When next you figure on insulation, consider the advantages you get with Foamglas on a cost per year basis. If you are facing special insulating problems, our specialists will be glad to consult with you. Meanwhile why not write or call your nearest distributor (see list on next page) for our descriptive booklet on industrial insulation and a sample of PC Foamglas, or write to Pittsburgh Corning Corporation, Dept. DD-31, 307 Fourth Ave., Pittsburgh 22, Pa.



The towers of this new refinery are insulated with PC Foamglas, finished with corrugated aluminum. Foamglas comes in standard flat blocks, curved segments and beveled lags to fit many types of equipment. Insulation Contractor: The Aber Company, Inc., Houston, Texas.

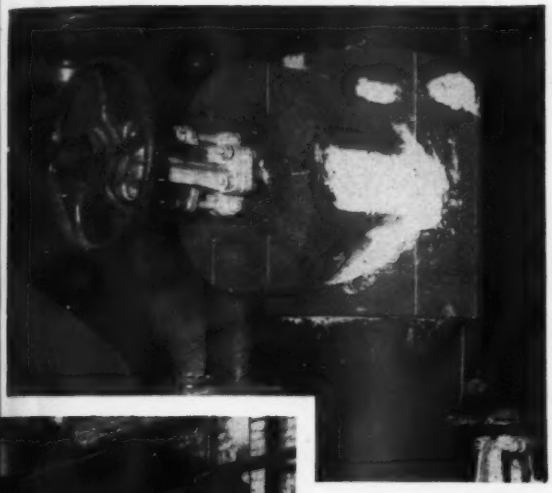
PITTSBURGH PC CORNING ®

FOAMGLAS cellular

...WHEN YOU INSULATE WITH FOAMGLAS...THE INSULATION LASTS!

XUM

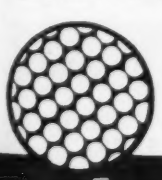
is PC Foamglas



Preformed sections of PC Foamglas are available for standard pipe sizes and fittings. Installation is quick and easy. Photo courtesy of North Brothers, Atlanta, Ga.

PC Foamglas, on sides and head of this evaporator will help maintain the 280° to 320°F. temperatures required for drying "green" wood prior to creosoting. Photo courtesy of Taylor-Colquitt Company, Spartansburg, S. C.

THIS MAGNIFIED DIAGRAM shows that PC Foamglas is composed almost entirely of still air, which is sealed in minute glass cells. The black areas indicate glass, the white areas air. The insulating properties of still air and the unusual resistance of glass to moisture, chemicals and other elements that cause insulation to deteriorate, make Foamglas an exceptionally effective, long lasting insulating material.



These prominent concerns distribute and install
PC FOAMGLAS INDUSTRIAL INSULATION
Write for descriptive literature

ALABAMA

Badham Insulation Company, Inc.
1909 First Avenue, South
Birmingham 3, Alabama

Insulation Engineers, Inc.
Conception St. Road & Kraft Highway
Mobile, Alabama

CALIFORNIA

Plant Asbestos Company
5309 Horton Street
Emeryville 8, California

Plant Insulation Company
2120 East 25th Street
Los Angeles 58, California

CONNECTICUT

The Insulation Company
624 Oakwood Avenue
West Hartford, Connecticut

FLORIDA

P. Richardson
311 Mendoza Avenue
Coral Gables 34, Florida

Asbestos Insulation Company
119 West 7th Avenue
P. O. Box 548
Tampa, Florida

GEORGIA

North Brothers
911 Boulevard, N. E.
Atlanta 1, Georgia

North Brothers
644 West Bay Street
Savannah, Georgia

ILLINOIS

Standard Asbestos Mfg. Company
860 W. Evergreen Avenue
Chicago 22, Illinois

INDIANA

M. H. Hilt, Inc.
2531 North Clinton Street
Fort Wayne 3, Indiana

Chas. W. Keagle Company
718 North Senate Street
Indianapolis 2, Indiana

IOWA

R. M. Daly & Company
520-22 W. Elm Street
Des Moines 9, Iowa

KENTUCKY

General Insulation & Roofing Co., Inc.
301 West Main Street
Louisville 2, Kentucky

LOUISIANA

The Aber Company, Inc.
1800 Old Benton Road
Shreveport, Louisiana

MARYLAND

The Standard Insulation Company
of Maryland, Inc.
1117 Low Street
Baltimore 2, Maryland

MASSACHUSETTS

Cork Engineering & Insulation Co., Inc.
57 Braintree Street, Allston
Boston, Massachusetts

MICHIGAN

Alexander-Strafford Corporation
1 Ionia, N. W.
Grand Rapids, Michigan

Michcork Company
730 Dix Avenue, South
Detroit 25, Michigan

Tony Batenburg Insulation Company
914 Roger Street, N. W.
Grand Rapids 4, Michigan

MINNESOTA

Asbestos Products, Inc.
710 Raymond Avenue
St. Paul 4, Minnesota

MISSOURI

Kelley Asbestos Products Company
2030 Grand Avenue
Kansas City 8, Missouri

NEBRASKA

Kelley Asbestos Products Company
1205 Farnam Street
Omaha, Nebraska

NEW JERSEY

Chas. S. Wood & Company, Inc.
27-31 Lombardy Place
Newark, 2, New Jersey

NEW YORK

Frontier Insulation & Asbestos, Inc.
46-48 Leroy Avenue
Buffalo 14, New York

Laco Roofing & Asbestos Company, Inc.
421-424 East Main Street
Falconer, New York

Chas. S. Wood & Company, Inc.
18 East 41st Street
New York 17, New York

NORTH CAROLINA

Starr Davis Company, Inc.
502 Guilford Avenue
Greensboro, North Carolina

OHIO

R. E. Kramig & Company, Inc.
222 East Fourteenth Street
Cincinnati 10, Ohio

Combustion Equipment & Insulation Co.
2301 Pittsburgh Avenue
Cleveland 15, Ohio

Asbestos Service Company
100 East Rayen Avenue
Youngstown 2, Ohio

OREGON

Asbestos Supply Company of Oregon
221 S. W. Front Avenue
Portland 4, Oregon

PENNSYLVANIA

Achenbach & Butler, Inc.
1508-16 Brandywine Street
Philadelphia 30, Pennsylvania

Industrial Furnace Supplies, Inc.
281 Corliss Street
Pittsburgh 20, Pennsylvania

TENNESSEE

North Brothers
2115 Maryville Pike
Knoxville, Tennessee

The M. H. Ellis Company
166 Monroe Avenue
c/o Builders Exchange
Memphis 2, Tennessee

TEXAS

The Industrial Insulators, Inc.
713 South Main Street
Borger, Texas

B. & B. Engineering & Supply Co., Inc.
2220 South Harwood Street
Dallas, Texas

The Aber Company, Inc.
206 Jensen Drive
Houston 1, Texas

Thermal Products Company
853 Lockwood Drive
Houston 12, Texas

VIRGINIA

C. E. Thurston & Sons, Inc.
30-32 Commercial Place
Norfolk 10, Virginia

Virginia Insulation Company, Inc.
112 South Adams Street
Richmond 15, Virginia

WASHINGTON

Asbestos Supply Company of Seattle
5035 First Avenue South
Seattle 4, Washington

Asbestos Supply Company of Spokane
1318 N. Maple Street
Spokane 12, Washington

Asbestos Supply Company of Tacoma
2410 East E Street
Tacoma 2, Washington

WEST VIRGINIA

Allied Service, Inc.
Spring & Bullitt Streets, Station A
Charleston, West Virginia

Asbestos & Insulating Company
901 Brooks Street
Charleston 21, West Virginia

WISCONSIN

Sprinkmann Sons Construction Co., Ltd.
418 North 2nd Street
Milwaukee 3, Wisconsin

glass INSULATION

ANY TYPE OF VALVE

any place, any time, by any power-source available

CAN BE OPERATED BY

Limitorque

- ✓ INSTANTLY
- ✓ ACCURATELY
- ✓ SAFELY
- ✓ DEPENDABLY

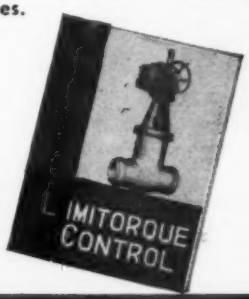
LimiTorque opens and closes valves of all makes and types up to 96" diameter by the "push of a button" from either remote or nearby control panels. Damage to stem, seat, disc, gate or plug is prevented because the Torque Seating Switch *limits the torque*, shuts off the motor if an obstruction occurs.

Greater safety is afforded workmen by LimiTorque Remote Control as it is unnecessary to go to high, low or dangerous locations for manual operation.

LimiTorque may be actuated by any available power source . . . electricity, steam, water, gas, oil or air.

LimiTorque Controls are obtainable through valve manufacturers. Thousands in daily use on land and sea . . . in Power Plants, Central Stations, Water Works, Refineries, and Oil Pipe Lines.

For full details . . . write for Catalog L-50 — please use your Business Letterhead.



Philadelphia Gear Works, INC.

ERIE AVE. AND G ST., PHILADELPHIA 34, PA.

NEW YORK • PITTSBURGH • CHICAGO • HOUSTON

IN CANADA: WILLIAM AND J. G. GREEY LIMITED, TORONTO

Industrial Gears and Speed Reducers
LimiTorque Valve Controls

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Remember—

the trade marks "tt" and "TUBE-TURN" are applicable only to products of TUBE TURNS, INC.

Bring on your severe conditions—

YOUR FIRST CHOICE for *severe service* conditions in piping is the TUBE-TURN Welding Neck Flange. It is engineered with a long tapered hub and a smooth transition in thickness to the pipe-end bevel. This means greater pressure-containing capacity under extreme temperature as well as much longer life than other types when repeated pipe bending or severe vibrations are involved.

For other jobs choose from these TUBE-TURN Welding Flanges: slip-on flanges; lap-joint flanges; socket-welding flanges; blind flanges; orifice flanges; pipeline non-standard flanges. Get in touch with your nearby TUBE TURNS' Distributor. You'll find one in every principal city.

Write Dept. J-3 for free booklet, "Research on the Cyclic Life of Piping Systems."

"Be sure you see the double tt"

TUBE TURNS, INC. LOUISVILLE 1, KENTUCKY

DISTRICT OFFICES: New York • Philadelphia • Pittsburgh • Chicago • Houston • Tulsa • San Francisco • Los Angeles
TUBE TURNS OF CANADA LIMITED, CHATHAM, ONTARIO... A wholly owned subsidiary of TUBE TURNS, INC.

XUM

Pipeliners speed up the job with uniform TUBE-TURN Welding Fittings

THE EASE with which you can get accurate alignment and fit-up when welding odd-angle TUBE-TURN Welding Elbows is a big help in getting top quality joints, say pipeliners in all parts of the country. That's because every single TUBE-TURN Welding Fitting has *true circularity* and *uniform wall thickness.*

It pays off . . . especially on the big jobs like the 30-inch pipe shown here. This feeder system of two 1½-mile gas lines over rough terrain included many odd angles . . . from 1½° to 90° . . . made with TUBE-TURN Welding Elbows.

The complete, versatile line of TUBE-TURN Welding Fittings also simplified construction of the compressor piping, expansion loops and other parts of this feeder system.

Photos courtesy Hope Natural Gas Company

DISTRICT OFFICES

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TUBE TURNS, INC.

LOUISVILLE 1, KENTUCKY

Want research data?

Tube Turns, Inc. has prepared a booklet based on tests to determine cyclic life of piping systems. If you'd like a free copy just send the coupon.

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224 East Broadway • Louisville 1, Kentucky

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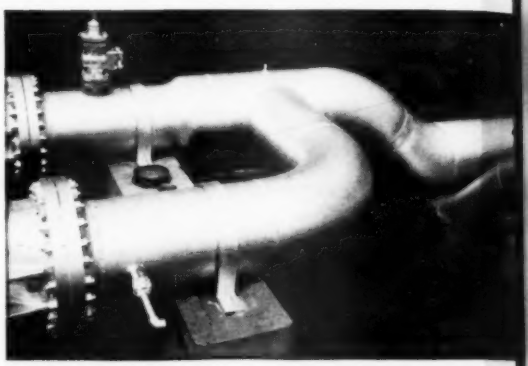
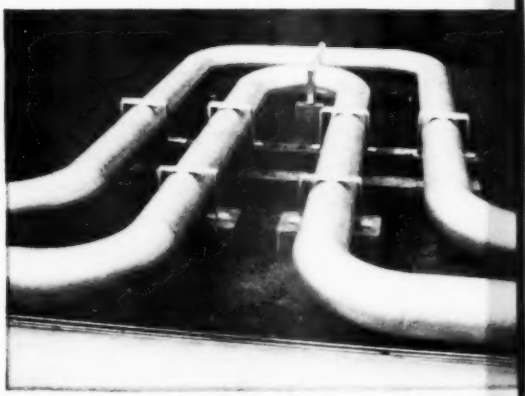
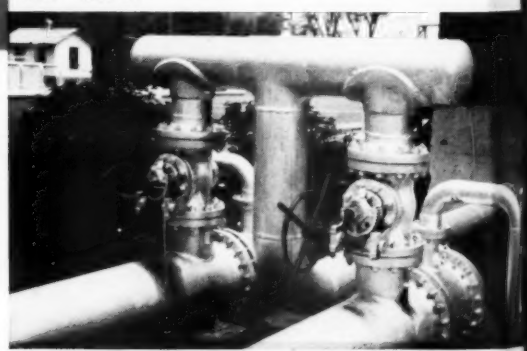
ODD-ANGLE PIPE LINE FITTINGS . . . 53°, 1½°, 13½° (left to right), these elbows will line up accurately with the pipe. Operating pressure of line will be 325-350 psi.



JUNCTION OF HEADERS from compressor discharge. Comprises 24-inch TUBE-TURN Welding Elbows—45° and 90° tee and reducer.



EXPANSION LOOPS for discharge piping from compressors. Fabricated from 20-inch TUBE-TURN Welding Elbows and Pipe. Operating pressure: 325-350 psi; Temperature: 280°– 300°F.



EN ROUTE TO COOLERS, this piping shows how TUBE-TURN Welding Fittings afford a compact, neat installation. Included are TUBE-TURN Welding Elbows, Tee, Saddles, Caps and Flanges.

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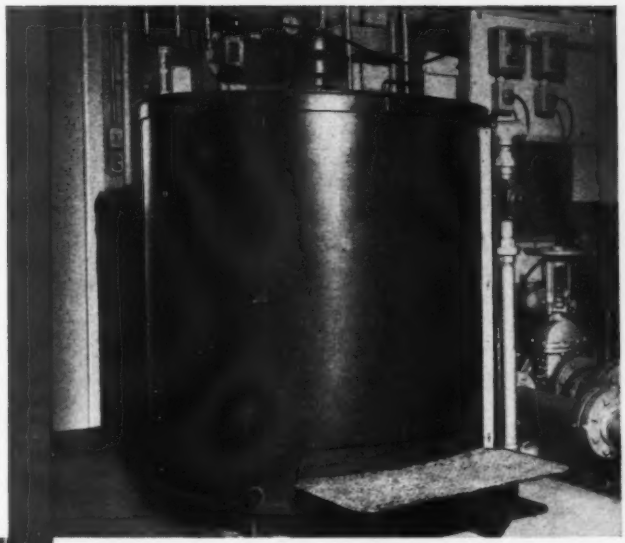
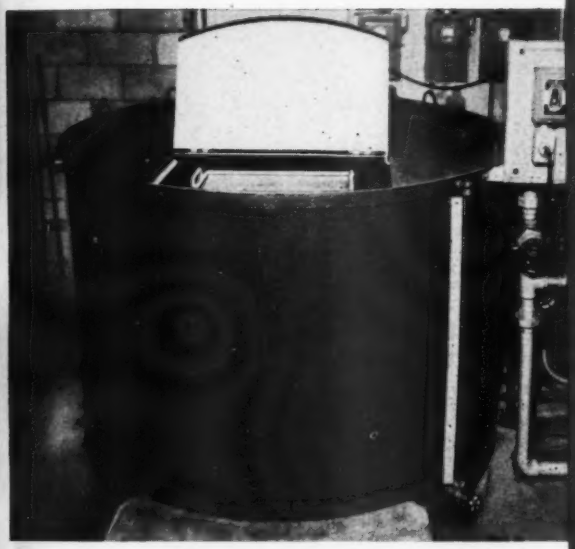
Everybody Talks about CORROSION...



Mixing tank using 3.3 per cent solution of ferrous sulphate at a Bradford, Pa., oil field. After 12 months of 24-hour-a-day service, coating based on VINYLITE Brand Resins shows no failure.



Water treating tank at same oil field, for solution containing 7 per cent caustic soda and 2.3 per cent Calgon. VINYLITE Resin coating also intact after continuous service for a year.

Here's What To Do About It!

More and more oil men, chemical manufacturers, processors, are finding that coatings based on VINYLITE Brand Resins cut the long-time cost of metal protection down to rock bottom!

Fundamental reason for this is the basic inertness of these resins...their powerful resistance to attack by oils, greases, water, salts, alkalies, most strong acids, and most other chemicals.

Add to this the fact that, when properly formulated, they are easy to apply by conventional methods, they air-dry rapidly, and they stay intact for long periods, maintaining their integrity and bond. Inherently tough, they are also resilient and able to withstand impact, shock and abrasion. They protect containers from contents and spillage. They protect contents from injury by containers.

You will find coating systems based on VINYLITE Brand Resins priced comparably with other quality finishes. But you'll find renewed savings year after year in the greatly reduced maintenance and refinishing costs that these long-lasting, chemical-resistant coatings make possible.

For more information and a list of representative suppliers, write Dept. KI-68.

Data on "HYSOL" 3000 and 4000 coatings courtesy of Houghton Laboratories, Inc., 322 Bush St., Olean, N. Y.

Vinylite BRAND **RESINS**

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A Division of
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Modern methods, backed by years
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your most dependable source
of steel castings.
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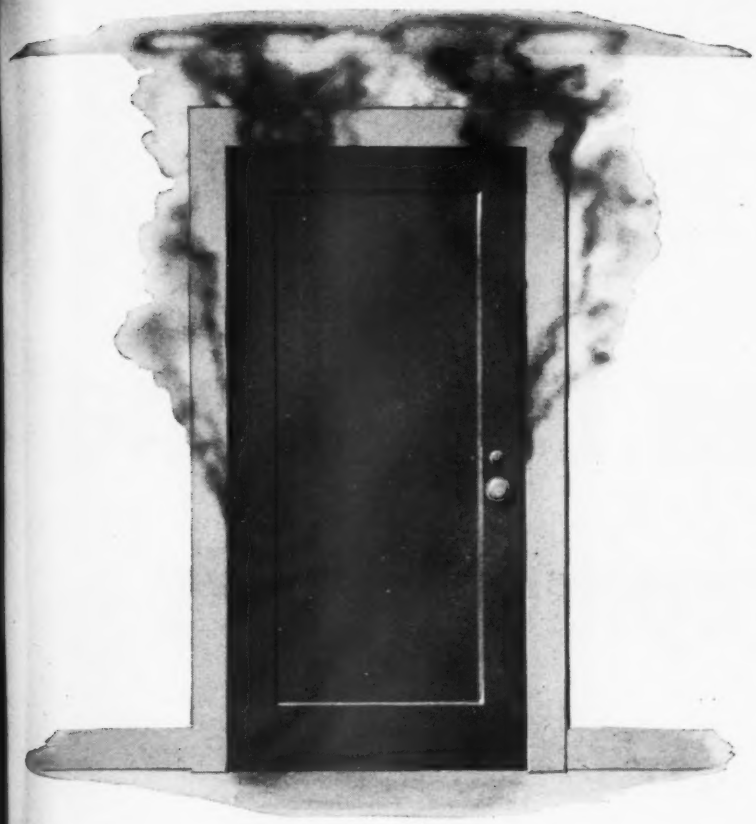

Where is the safest place to keep your documents?

Are your contracts, blueprints, accounts receivable—the records that keep your business going—really safe?

If you've ever seen business papers charred by fire . . . or made illegible by water from fire fighting, you'll want to make sure it can't happen to your records.

Wherever you store these papers, you can rely on a *Kidde* Fire Extinguishing System to protect them. A Kidde System uses carbon dioxide—a gas that won't mark, stain or discolor papers—and it puts out fire *fast*.

You can put a Kidde system on guard over one or many record vaults . . . ready at the first sign of flame to release a fire-smothering cloud of CO_2 . . . and do it *automatically*.

Why not go *all the way* in protecting your papers. Call a Kidde expert for full information.

Kidde

Walter Kidde & Company, Inc., 355 Main Street, Belleville 9, N. J.
In Canada: Walter Kidde & Company of Canada, Ltd., Montreal, P. Q.

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How you can up-grade valve replacements

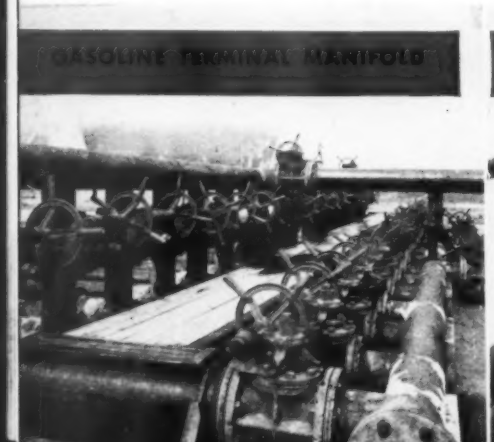
...without major investment

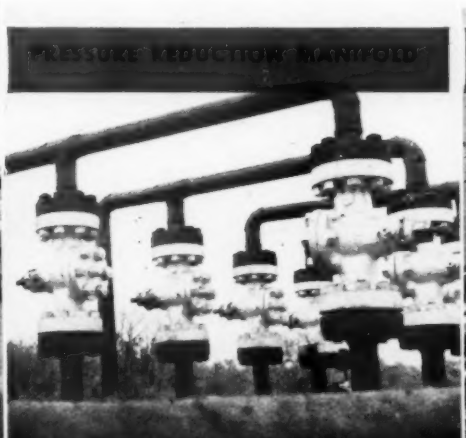
Why does a valve need replacing? Because it has either failed to operate, or cannot adequately handle the fluid. Replacing old style valves with like valves is usually force of habit—and it's easy to become a victim of habit. The way to break a bad habit is to substitute a new and better habit.

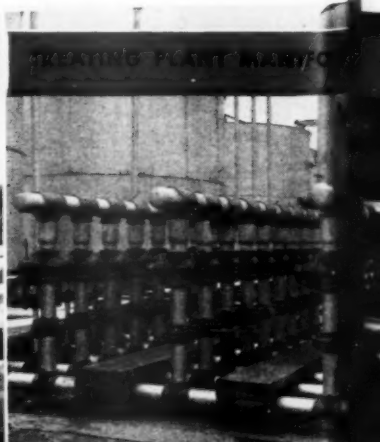
Get the Nordstrom habit. Every time you make a valve replacement, install a Nordstrom. You thereby gradually build up the standards of valve quality in your plant.

Take a manifold, for example. It may have a dozen or so old valves, some of which are giving you trouble. Requisition a Nordstrom for each replacement. Eventually the entire manifold will be 100% Nordstrom—completely modernized, trouble-free, leak-free, equipped to save operator's time—and, with Hypermatic, *automatically lubricated.*

Try this money-saving habit. Step up plant efficiency. Keep upkeep down with Nordstroms.







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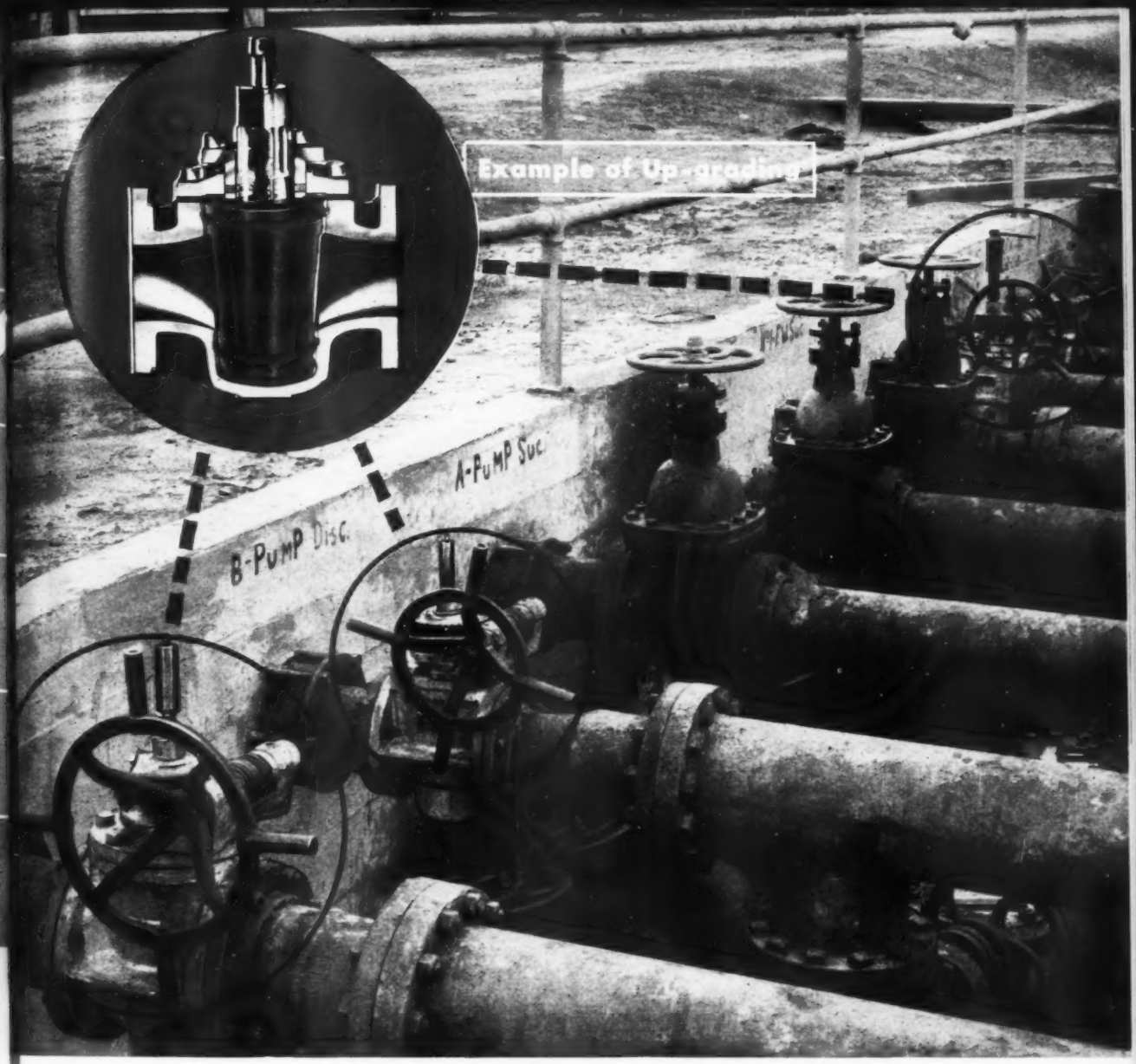

Adopt a progressive program of replacing obsolete valves with Nordstroms

Nordstrom Valves

AUTOMATICALLY LUBRICATED

ROCKWELL MANUFACTURING COMPANY

400 N. Lexington Ave. • Pittsburgh 8, Pa.
Atlanta, Boston, Chicago, Columbus, Houston, Kansas City, Los Angeles, New York, Pittsburgh, San Francisco, Seattle, Tulsa . . . and leading Supply Houses.
Export: International Division, Rockwell Manufacturing Company, 7701 Empire State Bldg., New York 1, N.Y.

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IF YOU ARE AN OLD TIMER...

If you are an old timer in the oil fields, you have probably used Thermoid Powerflex Rotary Hose for many years. And we don't need to tell you that the name "Thermoid" on any product is a sure sign of dependability. But we would like to remind you of the time and labor saving qualities of these two Thermoid Hoses:

Thermoid Mud-Flo Suction Hose
permits raising and lowering of suction pipe and changing the position of intake without changing connections. Reinforced with heavy galvanized round wire imbedded in the walls to prevent collapse and permit unobstructed flow.

Thermoid Flexible Discharge Hose
speeds rig-up and tear-down time between mud-pump and standpipe. Eliminates vibration that causes loosened connections, and avoids sharp angles that cause pressure loss and turbulence. Full flow couplings securely anchored for the life of the hose. Steel cables provide maximum flexibility—every length pre-tested to 5000 psi.

As always, it will pay you to specify Thermoid.

Mid-continent Office and Warehouse: Houston, Texas

SEE OUR CATALOG IN THE COMPOSITE CATALOG

Thermoid

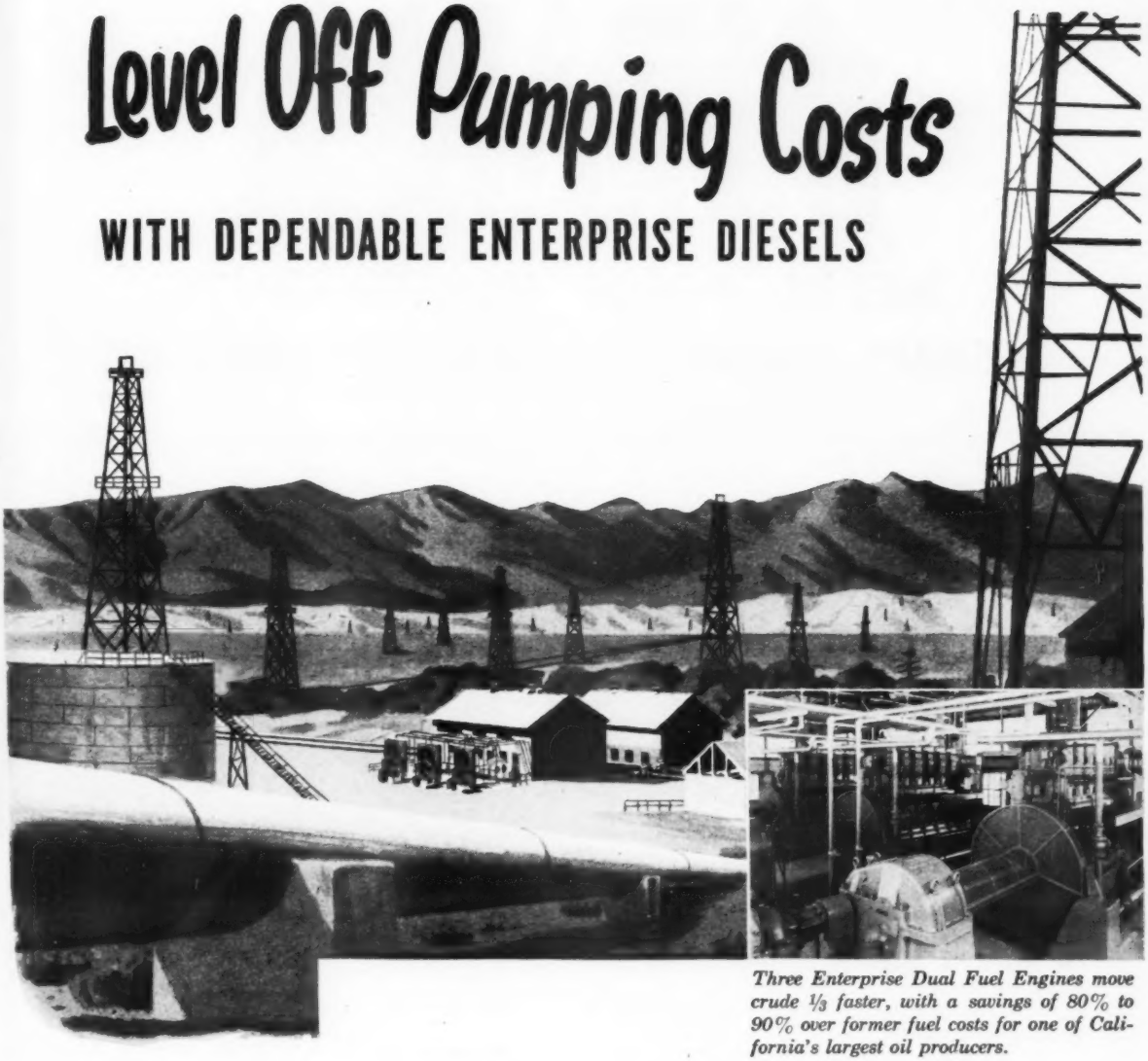
Powerflex Rotary Hose • Trioflex Slim-Hole Rotary Hose • Mud-Flo Slush Pump Hose • Flexible Discharge Units • F.H.P. and Multiple V-Belts • Oil Country Flat Belting

Wire Line Turn Backs • No-Wip Line Savers • Stuffing Box Rings • All Types of Hose • Molded Specialties • Brake Blocks

Thermoid Company • Offices & Factories: Trenton, N. J., Nephi, Utah

Level Off Pumping Costs

WITH DEPENDABLE ENTERPRISE DIESELS



Three Enterprise Dual Fuel Engines move crude 1/3 faster, with a savings of 80% to 90% over former fuel costs for one of California's largest oil producers.

Enterprise Diesels, Dual-Fuel and Spark Ignition Gas Engines, stationary and portable, are built in a wide range of models from 68 to 1755 HP. Generator sets to 1250 KW. Turbocharging available on most models.

Rugged and reliable, Enterprise Diesels are designed and built to cut power costs all along the line—from drilling rig to pipe line terminal. Modern installations of these medium and slow speed diesels are providing exceptional pumping service on a continuous, round-the-clock basis. Contributing to their high economy of operation are 1) simplicity of connection and control, 2) high torque at all speeds, 3) elimination of transmission losses, 4) adaptability to crude and residual fuels, and 5) smooth, vibration-free operation—even under excessive load. They provide the flexibility that's needed, too, using Diesel oil, crude, natural gas or dual-fuel. For *your* next diesel power job, investigate Enterprise—better built for longer life at lower costs.

Enterprise
STATIONARY
Diesels

The Choice of Power Experts

ENTERPRISE ENGINE & MACHINERY CO.
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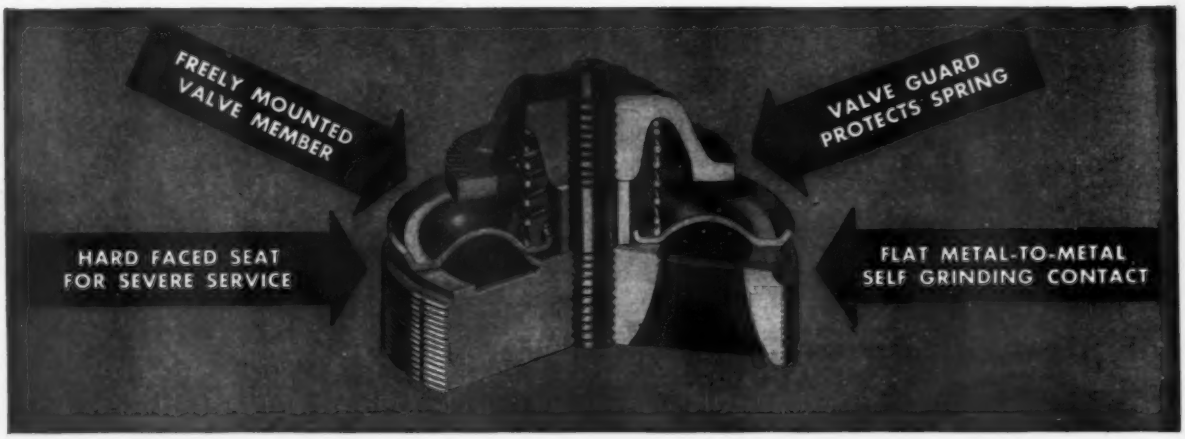
18th & Florida Streets, San Francisco 10, California
Offices in Principal Cities

DURABLA

METAL PUMP VALVE UNITS
KEEP YOUR PUMPS IN SERVICE


FREELY MOUNTED VALVE MEMBER
VALVE GUARD PROTECTS SPRING
HARD FACED SEAT FOR SEVERE SERVICE
FLAT METAL-TO-METAL SELF GRINDING CONTACT

1 **THEY ARE SELF-GRINDING:** Durabla Valve Units*, utilizing the freely mounted arched construction valve member exclusive to Durabla, are self-grinding, as the flat portion of the valve member is in direct contact with the flat valve seat and is free to move about its axis, thus producing a constant self-grinding action.

2 **VALVE SEATS ARE HARD FACED FOR SEVERE SERVICE:** Providing a seat surface hardness of Rockwell C-48-52 (approximately 500 Brinnel) or more in special valves, Durabla Valve Units have a long record of effective service with FLUIDS CARRYING SUSPENDED ABRASIVE SUBSTANCES. The metal valve member effectively prevents the pitting or "pick-up" of abrasive substances sometimes occurring with valves made of other materials.

3 **VALVE SPRINGS AND VALVE STEMS ARE PROTECTED:** The Valve Guard protects the Valve Spring from ever compressing more than 50% of its length. The Valve Stem is protected against breakage by the free mounting of the Valve Member.

Economy, efficiency and adaptability, based on long established service records and exclusive design make Durabla Valves your guarantee of reliable, uninterrupted pump operation.

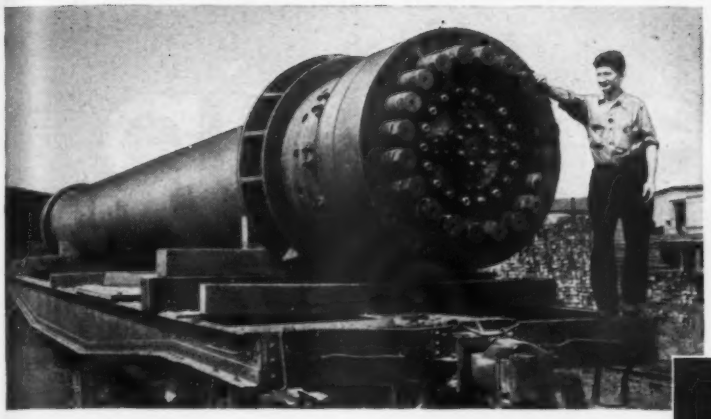
You can specify Durabla Valves when you order a pump, (many manufacturers use them as standard equipment), or you can order Durabla Valves to fit any type of reciprocating pump, (they come with drive-fit seats or threaded seats with or without a shoulder to suit the job).

TO AVOID "PUMP TROUBLES" SPECIFY DURABLA VALVES

Address DURABLA Engineering Department for information and bulletin: Reference OG-3

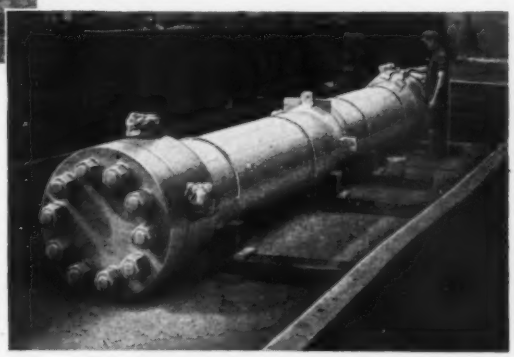
*Patent Numbers 2090486, 2117504

DURABLA MANUFACTURING COMPANY
114 LIBERTY ST. NEW YORK
BRANCHES IN PRINCIPAL CITIES. FOR CANADA REFER: CANADIAN DURABLA LIMITED, TORONTO



One of several MULTI-LAYER Converters designed for 5000 psi working pressure, with corrosion-resistant type 405 alloy inner shell. Wall thickness 8¾ inches, weight 182,000 lb. This type of construction is ideal for high pressure synthesis of coal and shale.

MULTI-LAYER Heat Exchanger designed for 5100 psi working pressure. Wall thickness 4¾ inches, weight 45,800 pounds.



A.O.Smith
MULTI-LAYER
Heat Exchangers & Pressure Vessels

The practical, *economical* solution to your high pressure process and storage requirements

MULTI-LAYER vessels are built-up from concentric layers of relatively thin steel plate, progressively *wrapped, tightened* and *welded* around an inner, pressure-tight cylinder.

Greater range of process possibilities for the planning and design engineer are provided in this unique, patented construction.

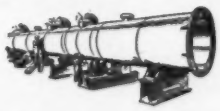
Walls can be made stronger merely by increasing strength of steel wrapping plates or by adding more layers.

For corrosive service, only the inner cylinder need be fabricated of alloy or non-ferrous materials.

No size or weight limitations as MULTI-LAYER vessels or heat exchangers can be made in any diameter for which satisfactory end closures are available.

The full calculated strength of the steel is more fully utilized in MULTI-LAYER vessels. Wrapping tension and weld shrinkage develop compression in the inner layers. This results in more equalized loading of all portions of the vessel wall under working pressure.

Safety is greatly improved by MULTI-LAYER construction. Only the inner cylinder need be pressure tight! Outer layers are provided with vent holes which protect the vessel against damage from over-pressure. In the remote event of run-away overload sufficient to cause failure, there is little danger of fragmentation of the vessel wall, due to the nature of MULTI-LAYER construction.



Consult A. O. Smith for assistance on your heat-exchanger or pressure-vessel problems. In any event, write for Bulletins V-52 and V-53 for more complete information on MULTI-LAYER Pressure Vessels and their construction . . . or use handy coupon.

A.O. Smith 77th Anniversary 1874 - 1951

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A. O. Smith Corporation
Dept. OG-351, Milwaukee 1, Wis.

Without obligation, send me Bulletins V-52 and V-53 on your MULTI-LAYER Pressure Vessels and their construction.

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MARINE EQUIPMENT

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OIL FIELDS

FLEXIBLE HOSE LINES with DETACHABLE FITTINGS

Easily assembled in your own shop.

Operating temperatures from —40° to +275° F.

For use with hydraulic fluids, lubricating oils, water, air and many other fluids.

SELF-SEALING COUPLINGS

Allow separation and reconnection of fluid-carrying lines without loss of fluids or inclusion of air. 1 coupling takes the place of 2 hand-operated valves.

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AEROQUIP PRODUCTS ARE FULLY PROTECTED BY PATENTS IN U. S. A. AND ABROAD

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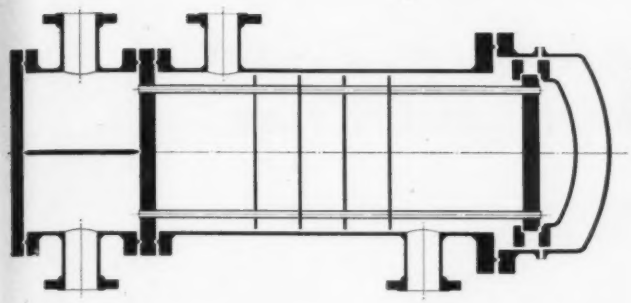
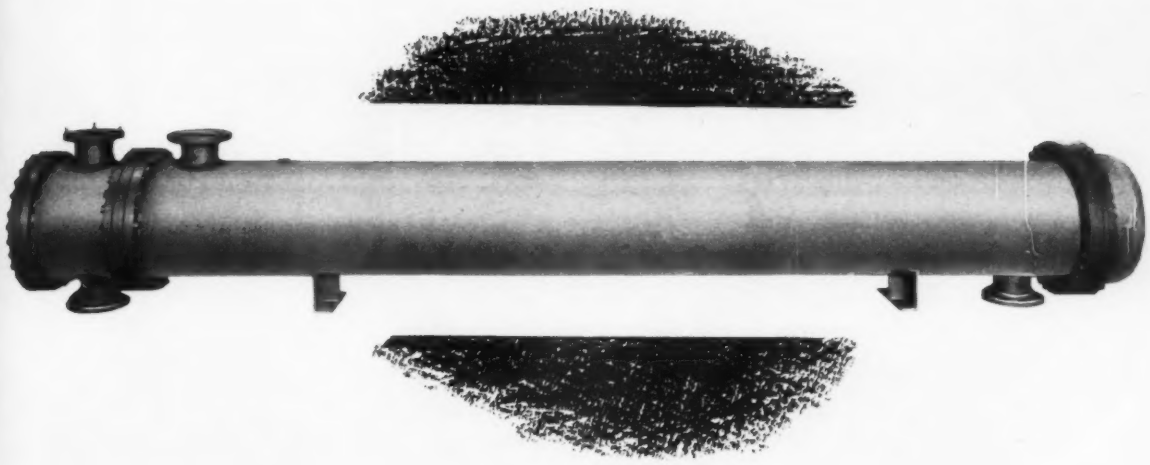
IT'S A HEAT EXCHANGER . . .

BY

WESTERN





More specifically it's a Multi-Pass Floating Head Removable Bundle Exchanger.

You say—"It won't serve my purpose"; we don't even question this, for the above exchanger was "Tailored" in the Western shops to do a *specific job* for a *specific customer!* However, we would like to file this thought with you . . . just as this exchanger was designed to handle one service condition within a particular plant . . . we are prepared to serve you in precisely that same way. Because of the extreme differences between individual refineries, and the equal extremes within the refining processes themselves, each heat transfer problem is likely to be unique. That's why we keep hammering away at the idea of TAILORED heat transfer equipment. Our designers and engineers are available to consult with you on your toughest heat exchanger needs. From the drawing board to the final installation they see to it that you get rigid engineering adherence to the particular specifications that you and Western have established. Materials are tightening up—you know it and we know it. Check your operational and maintenance requirements now, and if heat exchanger replacements are indicated, whether shell-and-tube exchangers, atmospheric sections or reboilers, call Western and place your problem with us.

WESTERN
HEAT EXCHANGERS

Manufactured by
WESTERN SUPPLY COMPANY
P. O. BOX 1888 TULSA, OKLAHOMA
SALES OFFICES — DALLAS — HOUSTON

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PROVIDED FOR YOUR CONVENIENCE

SEE OUR CATALOG IN SWEET'S

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Nash Instrument Air Compressors deliver only clean air, free from oil or dust, and without filters

Here is Why!

You can dispense with oil filters and dust filters when you install ®Nash® Clean Air Compressors. You can save the cost of maintaining these devices. You can greatly reduce instrument maintenance costs. For the Nash employs no internal lubrication, therefore no troublesome oil is in the delivered air. Moreover, air from a Nash is thoroughly washed and cooled as it passes thru the pump. Dust in the plant atmosphere, even fly ash, is immediately removed.

®Nash® Clean Air Compressors are simple, with only one moving element. No valves, gears, pistons, sliding vanes, or other enemies of long life and constant performance complicate a Nash. No aftercoolers are needed. You will find it profitable to investigate these pumps, now.

- No oil filters.
- No dust filters.
- No internal lubrication to contaminate air handled.
- No internal wearing parts.
- No valves, pistons, or vanes.
- Non-pulsating pressure.
- Original performance constant over a long pump life.
- Low maintenance cost.

NASH ENGINEERING COMPANY
395 WILSON, SO. NORWALK, CONN.

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Cameron NON-LUBRICATED LIFT-PLUG VALVES

Plug Actuator which lifts, turns and seats plugs in ¾ turn of operating lever.
Separate, renewable seat . . . easily changed without removing valve from line.

The costly refining and blending processes required to produce aviation gasoline may be partially nullified by greases which wash out of lubricated valves and stop cocks. This source of product contamination may be effectively eliminated through the use of Cameron NON-LUBRICATED Lift-Plug Valves. These remarkable valves operate easily and effect a positive closure without the aid of lubricants.

Aviation gasoline is one of a number of difficult industrial services where these remarkable valves have turned in an outstanding performance. They may hold the answer to ***your*** valve problems, too. Send today for literature.

CAMERON IRON WORKS, INC.

P. O. BOX 1212 • HOUSTON, TEXAS

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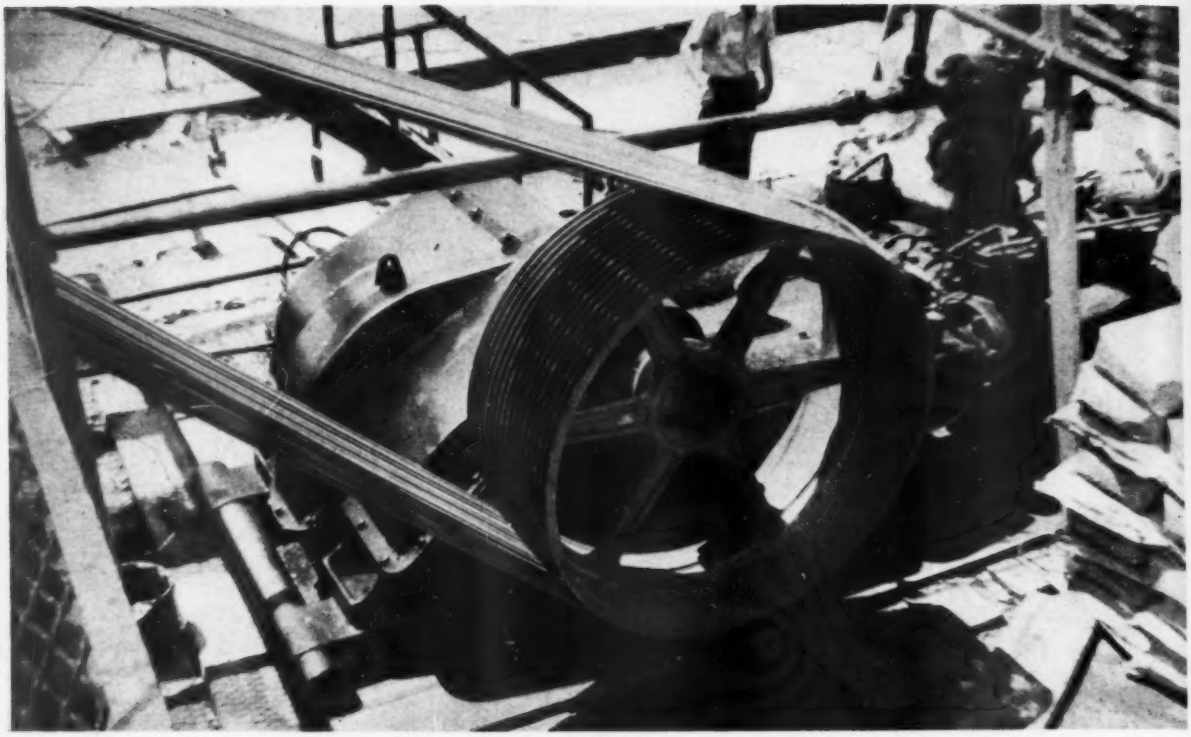


Born in The Oil Fields

now the top choice of all industry and still your best V-drive buy

That's a picture of the sheave that got its start in the Southwest and is now used more often—in all industry—than any other.

What's so good about the Worthington QD?

It's easy to get on, easy to get off, yet always tight on the shaft. Two-piece construction—you first put the light-weight, split hub on the shaft and lock it; then you slip the taper-bored rim over the cone-tapered hub and use the long pull-up bolts to make a positive press fit on the shaft.

Changing sheaves is just as easy. You use the bolts as jack screws to remove the rim; the hub stays put, so there's no re-alignment problem.

It's stronger, too. Only Worthington designs each size for the load it will carry—instead of proportioning the whole line from one design. And note those I-beam spokes—lighter, but stronger.

Service is good. Local distributor stocks—a complete range— are backed by factory stocks in Los Angeles, Fort Worth, Houston, Tulsa and New Orleans. Ask for Worthington QD*.

*Trade Mark

WORTHINGTON

THE GOOD RIGHT HAND OF INDUSTRY

WORTHINGTON PUMP AND MACHINERY CORPORATION

MULTI-V-DRIVE SALES DIVISION

Buffalo, New York

POWER TRANSMISSION: sheaves, V-belts, variable speed drives

PUMPS: centrifugal, power rotary, steam

AIR COMPRESSORS: water-cooled, air-cooled

MV.1.11

Modern cracking stills frequently require that the ends of still tubes are accurately machined to precise dimensions. The design varies with the type of fittings used. Shown above is a highly specialized type of alloy still tube end used by one of the major oil companies calling for a straight special type precision thread. Homer Bruckner is the operator.

Pittsburgh Seamless Still Tubes

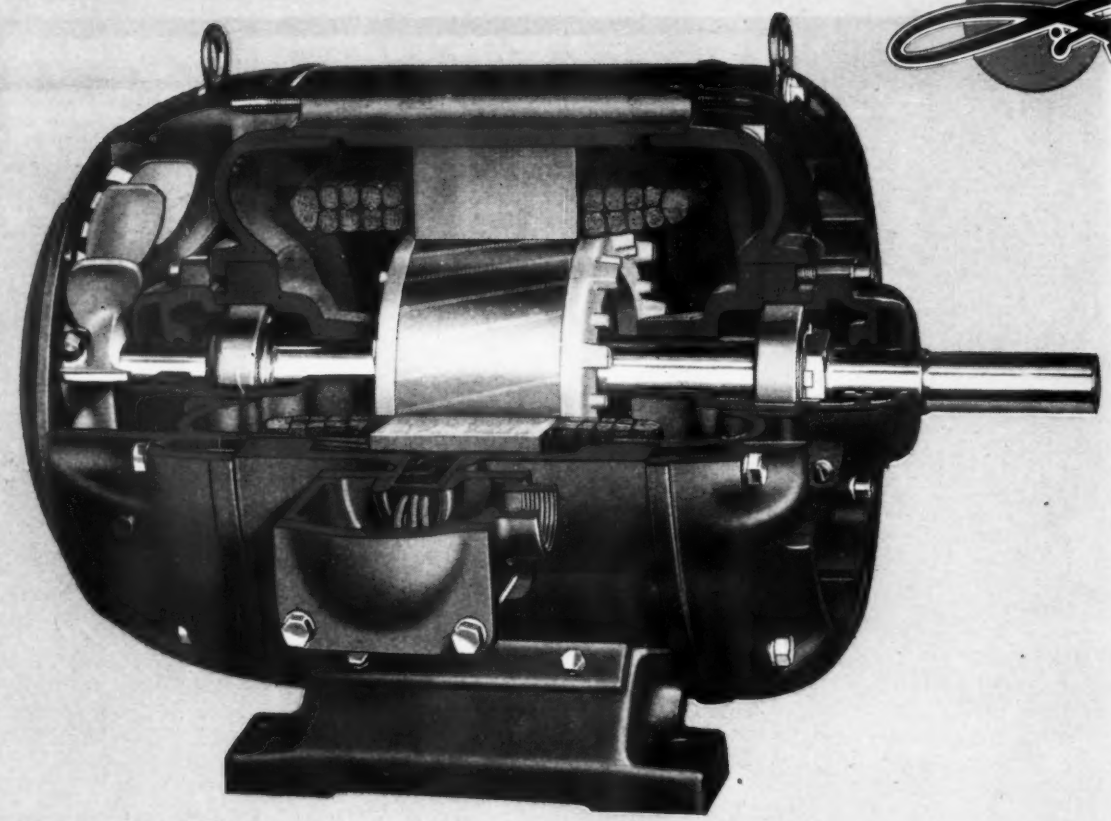
Are Precision Made for Uniform Performance

The uniform resistance to heat, pressure, oxidation and corrosion you get with Pittsburgh Seamless Still Tubes is the result of years of experience and skill in making high quality tubes. Refinery operators everywhere find this uniformity makes for ease of installation and long operation which gives them the economical performance that keeps their costs down—the production up.

Pittsburgh Seamless Still Tubes are made in a wide range of analyses ranging from low molybdenum and intermediate chrome-molybdenum alloys to the higher grades thus making it possible for you to select the most economical grade for the creep strength or corrosion resistance you desire. Pittsburgh Still Tubes are produced in sizes from 2″ to 6″ outside diameter (in some cases even larger) and from .134″ to 1″ average wall thickness in lengths up to 55′ with plain, upset or machined ends. You always get uniform performance and economy with Pittsburgh Still Tubes. Pittsburgh Steel Co., Dept. OG, Grant Building, Pittsburgh 30, Pa.

Pittsburgh Steel Company

LOUIS ALLIS



Look Inside!

The Louis Allis **EXPLOSION-PROOF** motor is designed and constructed to withstand the force of the most severe explosion possible within its heavy cast iron enclosure.

This Explosion-Proof motor has twenty carefully designed specific features — features that make available a new high in electric motor efficiency, dependability, convenience and—**SAFETY!**

These Explosion-Proof motors bear the Underwriters' Laboratory approved labels for all types of hazardous locations—Class I, Group D for explosive liquids and vapors — Class II, Group G for combustible dust—Class II, Group F for carbon black coal and coke dust—Class II, Group E for combustible metal dust.

LOOK INSIDE — compare the Louis Allis Explosion-Proof motor point by point with any others on the market—and we are sure you will agree that—here is the finest explosion-proof motor ever built—bar none!

Specify your next explosion-proof motor by name—**LOUIS ALLIS**—be assured of the most complete protection and dependable performance available.

THE LOUIS ALLIS CO.

Milwaukee 7, Wisconsin

50th YEAR 1901-1951

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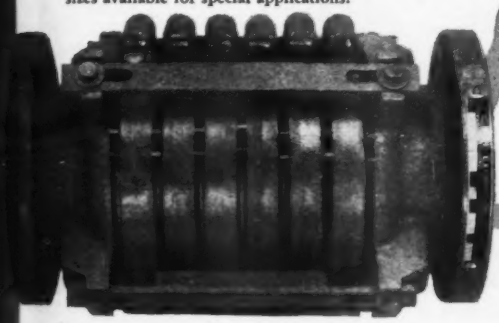
HERE'S WHY

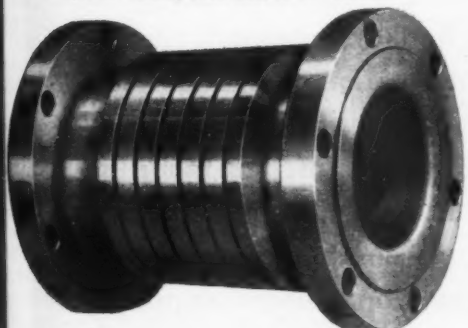
CMH Expansion Joints are preferred by so many piping engineers

CMH Free-Flexing Expansion Joints for pressures to 30 psi; stainless steel or copper; flanges or welding ends; standard sizes to 30" I.D.; larger sizes available for special applications.

- ✓ Space Saving
- ✓ Weight Saving
- ✓ Streamlined Flow
- ✓ Lower Overall Cost
- ✓ Ease of Installation
- ✓ Trouble Free Operation
- ✓ Freedom from Maintenance



CMH Controlled Flexing Expansion Joints for pressures to 300 psi; stainless steel or copper; flanges or welding ends; sizes to 30" I.D.



CMH Flexoniflex Expansion Joints with integral control rings for pressures to 1500 psi; stainless steel and other alloys; standard sizes ⅜" through 6" I.D.; larger sizes also available.

THE PROBLEMS of pipe motion control are reduced to a minimum when you use CMH corrugated type expansion joints. Scientifically formed by advanced methods, they represent the modern, cost-saving, trouble-saving way to control axial, lateral or radial motion in piping or to correct for misalignment.

For new installations or for replacement of obsolete equipment, specify CMH expansion joints. Complete data is given in CMH'S Expansion Joint Design Guide. Write for a copy . . . it's the first step towards eliminating the headaches that are so often a part of pipe-line motion control.

Flexon identifies CMH products that have served industry for over 49 years.

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Stainless Steel and Brass Bellows • Flexible Metal Conduit and Armor • Assemblies of These Components

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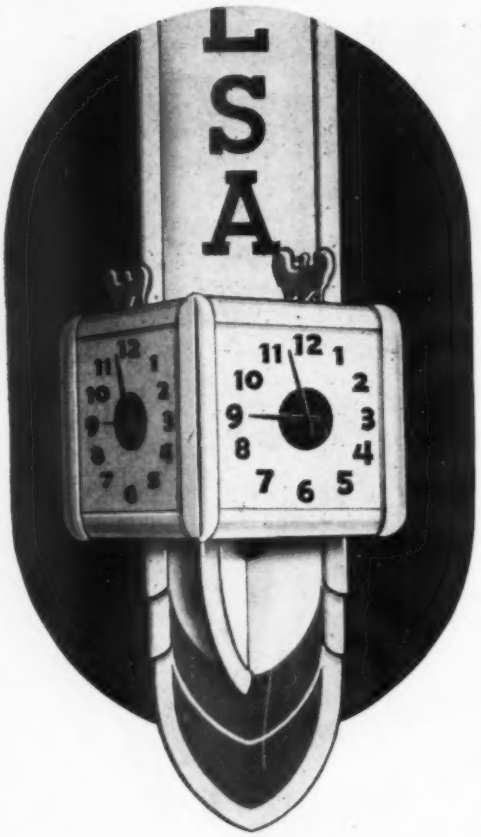

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TO DISCUSS OIL FINANCING

Any time you bring your financial problems to NBT oil bankers, you will receive the prompt attention of men who have had long experience in handling such matters. You receive the benefit of our facilities. NBT has the resources to finance your operations. Many oil companies and independent operators; contractors, suppliers and service organizations have met their needs through NBT oil loans.

The Oil Bank of America

NATIONAL BANK OF TULSA

OFFERING COMPLETE BANKING AND TRUST SERVICES

MEMBER FEDERAL DEPOSIT INSURANCE CORPORATION

They Say—

TEL Approval

"Recent orders allocating tetraethyl lead fluid will cause only slight reductions in the antiknock characteristics of motor fuels throughout the country.

"To most motorists the effect of the allocation orders for the purpose of stockpiling lead fluid will be scarcely noticeable. Only a drastic change for the worse in the world situation would cause a serious cutback in the quality of gasoline.

"Although lead supplies are now rationed refiners still have an opportunity to give full play to their initiative and resourcefulness in seeking to maintain motor-gasoline octane quality. This is the type of challenge oil men are accustomed to meeting."

—Edward J. Pease, industrial products manager for Sun Oil Co., speaking as representative of Massachusetts Oil Industry Information Committee.

Depletion Defended

"The State of Alabama is at the threshold of an intensified oil-development campaign which would be seriously retarded by any reduction in the 27½ per cent oil and gas depletion allowance.

"The oil industry, if allowed to proceed with the present impetus of recent discoveries, would soon become one of Alabama's principal industries, and it is the opinion of the experienced geologists that many more important oil pools will be discovered in our state.

"A large portion of southern Alabama has been leased for exploration by both major and independent oil companies. Two good pools have been found. These pools have proven the existence of the same formations from which prolific production is being recovered in Mississippi, Arkansas, and Louisiana.

"The proposed reduction in statutory depletion would be bound to hold back development which is now getting such a good start and which promises to continue and increase if no excessive tax measures are enacted."

—James L. Duffy, independent operator, Grove Hill, Ala., in testimony before the House ways and means committee.

Using Up Our "Fat"

"In this period of mobilization we have already been experiencing, and will continue to experience, the petroleum industry has been using up its "fat" more rapidly than was expected.

"What's the prospect when we analyze the total industry's surplus

JOINS 'EM RIGHT
KEEPS 'EM TIGHT

The COMPLETE Victaulic System is the EASIEST WAY TO MAKE ENDS MEET! Victaulic offers a complete line of Full-Flow Elbows, Tees and other fittings, all carefully designed for free-flowing efficiency and leak-tight dependability.

Join 'em right — the Victaulic way — and you'll be sure of easy, quick hook-ups. Pipe ends are joined by a simple two-bolt coupling. A speed or T-wrench is the only tool required. AND Victaulic Couplings keep 'em tight ... pipe joints stay positive-locked, leak-proof. Victaulic Couplings are designed to stand up under extreme pressure, vacuum, or strain conditions.

Preparing those pipe ends is a cinch the Victaulic way..."Vic-Groover" grooves 'em automatically in a jiffy, more than twice as fast as a conventional pipe threader!

SAVE time, work, and dollars on your piping construction and maintenance. JOIN UP with Victaulic.

Make your next piping job ALL VICTAULIC. Write today for Victaulic Catalog and Engineering Manual No. 44-8F.

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Sizes—¾" through 60"

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27TH VICTAULIC YEAR

The easiest way to make ends meet
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PIPE COUPLINGS AND FITTINGS

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WITH THE LOW-COST GUIBERSON B-1!

Positive Low-Pressure Seal

Running or pulling tubing, prevents oil or gas escape—pays for itself in savings!

Low-Pressure Blowout Preventer

Tested to 800 PSI, seals under working pressures to 300 PSI.

Eliminates Fire, Accident Hazards

Keeps derrick floor and equipment clean—passes collars.

TUBING OIL SAVER— BLOWOUT PREVENTER

For safety and economy on low-pressure wells the Guiberson B-1 is unequalled! Low initial cost... rubbers can be changed without removing from well head.

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capacity—the capacity to produce crude, refinery-run capacity, and transportation availability—that is tankers, pipe lines, etc.? On the average, the surpluses seem to have been in 1950 about the same as in 1941, 10 years earlier, measured in terms of barrels per day. The cushion, however, is not as great as it was in 1941 because the industry did about 55 per cent more business in 1950 than it had done 10 years previously. . . .

"If we are going to keep as comfortable a surplus capacity, or try to keep as comfortable a capacity, during the current situation as we have had in the past we would have to provide, not the 265,000 bbl. per day capacity each year as in the past, but over 600,000 bbl. per day. In other words, something like $3,000,000,000 annually would have to be spent for new capacities. . . .

"More capacity is needed at the refinery level and is needed urgently. More transportation is also needed. The burst of plant expansion following the 1947-1948 shortage scare left the industry in a comfortable position, but we have been using up our "fat" faster than we have realized. It is very doubtful that the industry can expand its capacity adequately and in time to remove all concern about next winter. The only way around the situation that seems to present itself as a practical and feasible solution is to summer fill product inventories. . . ."

—Dr. Courtney C. Brown, economist for Standard Oil Co. (N.J.) in an address before the Oil Industry Information Committee in New York.

CALENDAR

1951

March

Illinois Oil and Gas Association, sixth annual meeting, Mount Vernon, Ill., March 31.

April

American Gas Association, industrial and commercial gas section, conference on industrial and commercial gas, Shoreham Hotel, Washington, D. C., April 2-4.

Western Petroleum Refiners Association, annual meeting, Plaza Hotel, San Antonio, April 2-4.

American Society of Mechanical Engineers, spring meeting, Atlanta, April 2-5

Oil-Heat Institute of America, annual convention and National Oil-Heat Exposition, Navy Pier and Palmer House, Chicago, April 2-6.

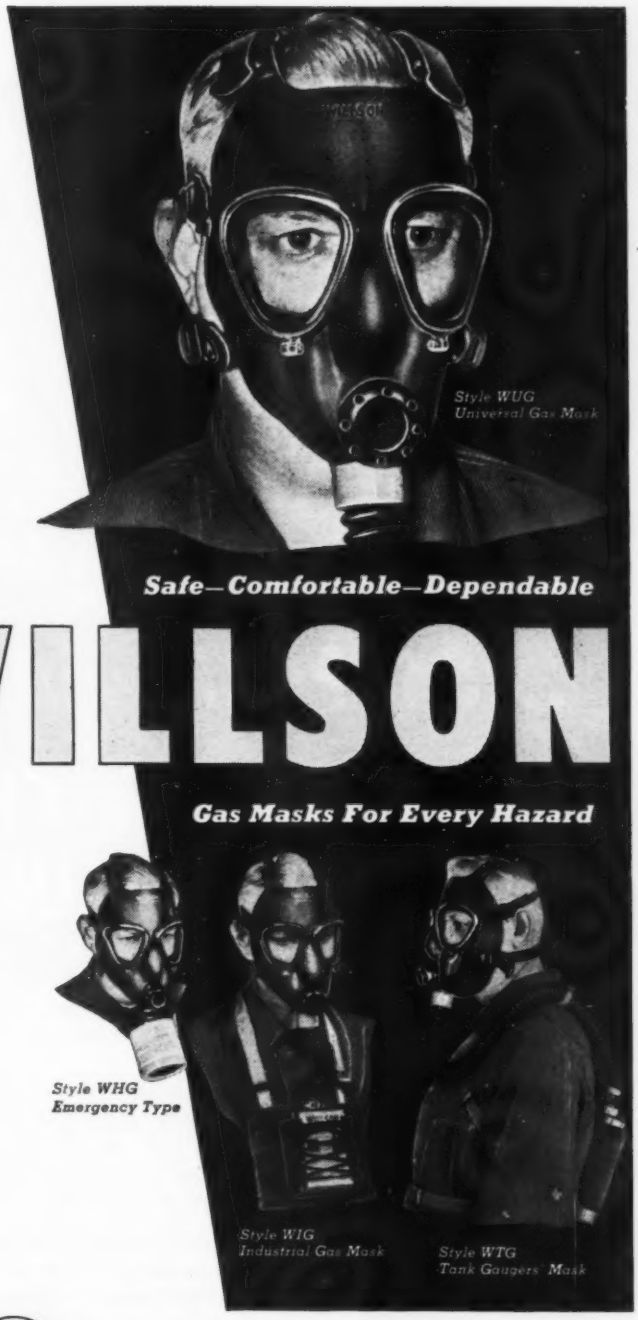
Instrument Society of America, New Jersey section, Essex House, Newark, N. J., April 3.

American Petroleum Institute, division of production, Eastern district meeting, Deshler-Wallick Hotel, Columbus, Ohio, April 3-5.

Pacific Coast Gas Association, annual distribution (technical) meeting, Riverside, Calif., April 4-5.

Midwest Power Conference, fourteenth annual meeting, Sherman Hotel, Chicago, April 4-6.

Second Annual Combustion Conference, sponsored by Department of Mechanical



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Dependable Products Since 1870
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For effective protection against acid gases, organic vapors, carbon monoxide, fumes, mists, smokes and similar hazards, there is a WILLSON Gas Mask approved by the U. S. Bureau of Mines. They have been designed with every consideration for worker safety and comfort. A selector table and complete information on various types is included in our new catalog. Ask our nearest distributor for a copy—or write direct to WILLSON PRODUCTS, INC., 204 Washington Street, Reading, Pa.

Something new

...a SEPARATE DIVISION for the CHEMICAL and PETROLEUM INDUSTRIES

The creation of a separate CHEMICAL-PETROLEUM DIVISION for these two vastly important industries is our recognition of the great progress taking place in the Chemical-Petroleum Field and of the continuous increase in volume of business to National Airoil Burner Company from that Field.

For almost 40 years National Airoil Burner Company has, step by step, kept pace with developments in the Chemical-Petroleum Industries. Now, we take added confidence and pride in knowing that we will be even better able to serve these industries.

We know you will be interested in the full particulars we can give regarding your oil-gas-sludge combustion requirements.

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INDUSTRIAL OIL BURNERS, GAS BURNERS, FURNACE EQUIPMENT

Engineering, University of Tennessee, Knoxville, April 5-6.

American Chemical Society, 119th national meeting, Hotels Statler and Cleveland, Cleveland, April 8-12.

New York Oil Heating Association, Inc. Hotel Statler, New York, April 9.

American Petroleum Institute, lubrication committee, Division of Marketing, spring meeting, Book-Cadillac Hotel, Detroit, April 9-10.

Mid-West Regional Gas Sales Conference Edgewater Beach Hotel, Chicago, April 9-11

Michigan Petroleum Association, annual spring convention, Detroit Leland Hotel Detroit, April 10-11.

Southwestern Gas Measurement Short Course, University of Oklahoma, Norman April 10-12.

American Institute of Electrical Engineers, District 4 meeting, McFadden-Deauville Hotel, Miami, April 11-13.

American Gas Association, distribution motor vehicle, and corrosion conference Hotel Peabody, Memphis, April 16-18.

American Society of Lubrication Engineers, annual convention and lubrication show, Bellevue-Stratford Hotel, Philadelphia, April 16-18.

Petroleum Industry Electrical Association and Petroleum Electric Supply Association, twenty-third annual joint conference, Hotel Adolphus, Dallas, April 17-19.

National Petroleum Association, Hotel Cleveland, Cleveland, April 18-20.

American Petroleum Institute, Rocky Mountain district spring meeting, Gladstone Hotel, Casper, Wyo., April 19-20.

Second Petroleum Recovery Conference, sponsored by Texas Petroleum Research Committee and petroleum-engineering department of Texas A. & M. College, College Station, April 19-20.

Florida-Georgia Gas Association, Hollywood Beach Hotel, Hollywood Beach, Fla., April 19-21.

Brussels International Fair, twenty-fifth annual event, Brussels, Belgium, April 21-May 6.

Southern Gas Association, Buena Vista and Edgewater Gulf hotels, Biloxi, Miss., April 23-25.

American Association of Petroleum Geologists, Society of Economic Paleontologists and Mineralogists, Society of Exploration Geophysicists, joint annual meeting, Jefferson Hotel, St. Louis, April 23-26.

Indiana Independent Petroleum Association, spring convention, Oliver Hotel, South Bend, Ind., April 25-26.

Natural Gasoline Association of America annual convention, Mayo Hotel, Tulsa April 25-27.

Indiana Gas Association, French Lick Springs Hotel, French Lick, Ind., April 26-27.

Pacific Coast Research Conference, Berkeley, Calif., April 26-27.

Interstate Oil Compact Commission, spring meeting, La Fonda Hotel, Santa Fe, N. M., April 26-28.

American Gas Association, industrial and commercial gas section, industrial gas school, William Penn Hotel, Pittsburgh April 29-May 4.

American Geophysical Union, thirty-second annual meeting, National Academy of Sciences, Washington, D. C., April 30-May 2.

American Petroleum Institute, division of refining, sixteenth mid-year meeting, Mayo Hotel, Tulsa, April 30-May 3.

Materials Handling Conference, International Amphitheatre, Chicago, April 30-May 4.

May

American Institute of Electrical Engineers, District 1 meeting, Hotel Syracuse, Syracuse N. Y., May 2-4.

New York Oil Heating Association, Inc., Hotel Statler, New York, May 7.

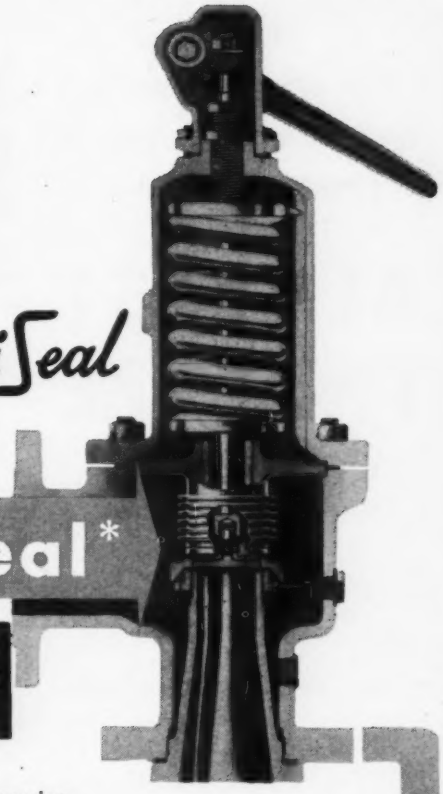
American Gas Association, Natural-Gas Department, Dallas, May 7-8.

Independent Petroleum Association of America, mid-year directors' meeting, Cosmopolitan Hotel, Denver, May 7-8.

Gas Appliance Manufacturers Association, natural-gas department spring meeting, Dallas, May 7-9.

Liquefied Petroleum Gas Association

meet the newest member of the *FarriSeal* family



BalanSeal*

IT SAVED $75,000 IN PIPING WITH A $5,000 VALVE INVESTMENT**

Pioneered by Farris Engineering Corp., embodying advanced engineering technics, *and absolutely unique*—although it is now being imitated—the patented BalanSeal is ideally suited for use wherever a collecting system is required for a series of safety-relief valves. It permits a higher downstream pressure—and consequently, smaller piping. Yes! The cost of a BalanSeal valve installation is a mere fraction of the savings effected in down-stream piping. (**In one case, a cost reduction of $75,000 resulted from a $5,000 investment in BalanSeal Valves.)

In BalanSeal, the sole force opposing the opening of the valve is the spring. Downstream back pressure, static or surge, cannot act on the disc and has absolutely no effect on the relieving point.

BalanSeal is the ultimate in safety-relief valve design and construction. The bellows, which also distinguishes the FarriSeal design, is so proportioned as to eliminate any unbalanced forces on the valve disc—which is perfectly balanced on its seat at the set pressure. Like all other FarriSeal Valves, perfect protection is provided for guide, stem and spring by completely isolating these parts from the lading fluid.

Get the facts on the revolutionary BalanSeal Safety Relief Valve. Find out how you can cut installation costs to the bone, step up operating profits. Write for Bulletin No. 52B—it will pay off in ASSURED safety and installation economy.

*Patented and Patents Pending

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For all your cars, trucks and buses...

PYRENE Fire Extinguishers with

AT LEAST TWICE THE SERVICE LIFE

OF ORDINARY VAPORIZING LIQUID EXTINGUISHERS

Exclusive!
Vibration dampener protects pump mechanism.
Exclusive!
Tough brass linings guard valve housings.
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BRAND B
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PYRENE (Vehicle Type)
In vibrating machine tests, Pyrene outlasts others up to 15 to 1.

Constant vibration cuts short the life of most vaporizing liquid extinguishers installed on trucks and buses.

Not so with Pyrene* 1 qt. and 1½ qt. Vehicle Type Extinguishers. When subjected to vibration, they'll give at least twice the life of ordinary extinguishers.

A special vibration dampener holds the Pyrene pump mechanism firmly in place, protecting it against both vertical and horizontal vibration. And tough brass linings guard the valve housings in every spot where wear would occur. *No other extinguisher offers these vital added construction safeguards.*

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Lower price doesn't pay when you get half the life! Buy on facts . . . buy Pyrene!

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FIRE EXTINGUISHERS

PYRENE MANUFACTURING COMPANY
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Affiliated with C-O-Two Fire Equipment Co.

annual convention and trade show, Stevens Hotel, Chicago, May 7-10.

American Petroleum Institute, division of production, Pacific Coast district, spring meeting, Biltmore Hotel, Los Angeles, May 10-11.

Pennsylvanian Geology and Mineral Resources of Western Indiana, fifth annual field conference, sponsored by division of geology, Indiana Department of Conservation, and department of geology, Indiana University, Bloomington, Ind., May 11-13.

American Institute of Chemical Engineers, regional meeting, Hotel Muehlebach, Kansas City, May 13-16.

American Gas Association, operating section, production and chemical conference, Hotel New Yorker, New York City, May 14-16.

Pennsylvania Gas Association, Wernersville, Pa., May 15-17.

Pacific Coast Gas Association, annual transmission (technical) conference, Bakersfield, Calif., May 16-17.

American Institute of Electrical Engineers, District 5 meeting, Loraine Hotel, Madison, Wis., May 17-19.

Empire State Petroleum Association, Inc., Hotel Statler, Buffalo, N. Y., May 20-22.

Second annual John Zink Process Heating Seminar, John Zink Co., 4401 South Peoria Avenue, Tulsa, May 26.

American Petroleum Institute, division of marketing, mid-year meeting, Cincinnati, May 28-29.

Third World Petroleum Congress, Kurhaus, Scheveningen, the Netherlands, May 28-June 6.

American Petroleum Institute, standardization and standing committees, division of production, mid-year meeting, Brown Palace Hotel, Denver, May 28-June 1.

Institution of Gas Engineers, London, England, May 29-June 1.

Natural Gas and Petroleum Association of Canada, Royal Connaught Hotel, Hamilton, Ont., May 31-June 1.

June

Society of Automotive Engineers, Inc., summer meeting, French Lick Springs Hotel, French Lick, Ind., June 3-8.

New York Oil Heating Association, Inc., Hotel Statler, New York, June 4.

American Society of Mechanical Engineers, semiannual meeting, Toronto, Ont., Canada, June 11-15.

Pennsylvania Grade Crude Oil Association, 1951 annual meeting, Hotel William Penn, Pittsburgh, June 14-15.

Petroleum Equipment Suppliers Association, annual meeting Chateau Frontenac, Quebec, Canada, June 17-20.

American Institute of Electrical Engineers, summer general meeting, Royal York Hotel, Toronto, June 25-29.

July

Wyoming Geological Association, sixth annual field conference, Rawlins, Wyo., July 31-August 3.

August

Society of Automotive Engineers, Inc., West Coast meeting, Olympic Hotel, Seattle, August 13-15.

American Institute of Electrical Engineers, Pacific general meeting, Multnomah Hotel, Portland, Ore., August 20-23.

NOMADS

Tulsa Nomads, third Friday of each month. After Five Room, Tulsa Hotel.

Dallas-Fort Worth Nomads, first Monday of each month, Greater Dallas Club.

Houston Nomads, second Monday of each month. Ye Ole College Inn, Houston.

Los Angeles Nomads, second Wednesday of each month, Jonathan Club.

New York Nomads, first Monday of each month, Louis Sherry's, 300 Park Ave.

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Yours the problem—

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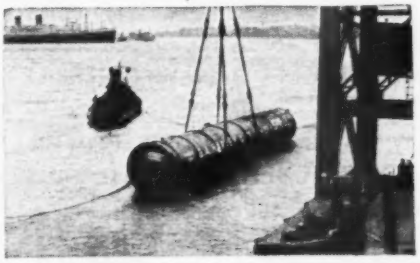
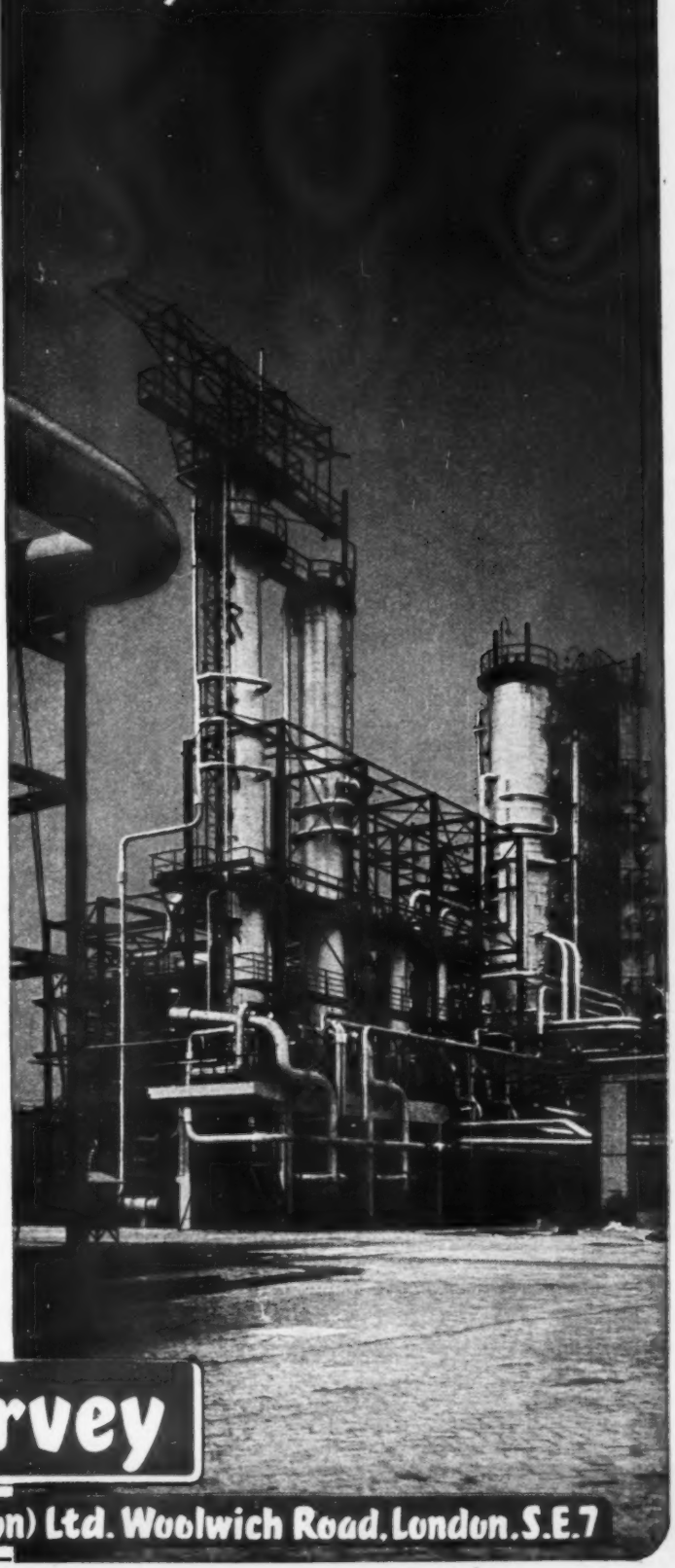
Because Harveys have one of the most modern and complete plants in the world, housing up-to-date Rolling, Bending, Pressing and Welding Equipment, operated by an experienced staff, they can supply the answer to even the most complicated plate-work problem. Typical examples of their work for the Oil Industry are shown in the accompanying photographs of Fractionating Columns supplied to the Royal Dutch Shell Group at their Pernis Refinery near Rotterdam.



A completely fabricated column is lowered into the Thames near the works—

Towed across the North Sea to Holland—

and lifted from the water at Pernis—quickly to take its part in this new Oil Refinery.



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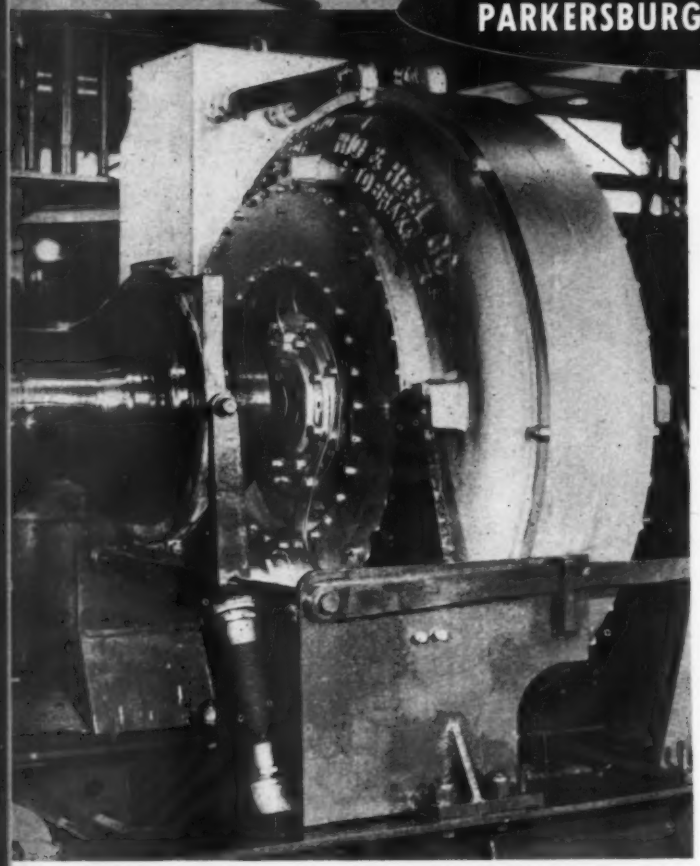
over 30% more BRAKING POWER

PARKERSBURG 46" Super Hydromatic



This "Super 46" is the biggest and most important drawworks brake development of the past 10 years. Actual field tests prove that it delivers OVER 30% MORE POWER THAN THE 40" DOUBLE ROTOR HYDROMATIC. And the "Super 46" costs no more.

The "Super 46" develops 7000 H.P. at 400 R.P.M. and 4700 H.P. at 350 R.P.M. In comparison, the 40" Double Rotor Hydromatic delivers 5000 and 3500 H.P. respectively at the same speeds. Throughout its entire range of speeds, up to 500 R.P.M., the "Super 46" delivers similar increases in braking power. On a drawworks with a drum diameter of 30" and 8 lines, the "Super 46", when operated at full capacity, will hold a 200,000 lb. load to a speed of 90′ in 19 seconds. It packs all the power you need to meet any braking problem encountered in 90% of today's deep drilling operations.

You can get immediate delivery on the "Super 46" Hydromatic from your drawworks manufacturer. Or modernize your present rig by installing the "Super 46". It has the same shaft size and taper as the 40" Double Rotor Hydromatic and it can be installed in the field quickly, easily and economically.

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No. 5102

ONLY THE *HYDROMATIC* OFFERS THESE ADVANTAGES!

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- Braking power increases automatically as the load increases.
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JOURNALLY Speaking

Question Game

QUIZ programs on radio and TV seem to be so popular that we decided to offer one to our readers. It starts on page 283 of this issue. It's all about refining, but don't stop here if refining isn't your specialty. If you'd like to see a similar quiz on another branch of the industry just check your wishes on one of the postcards you'll find there and drop it in the mail.

You can't break the bank, win a honeymoon in Hollywood, or collect any prizes for answering these questions correctly, but you can have a lot of fun testing your knowledge all by yourself and no embarrassing titters from the audience if you flub a few. This makes it a sort of refresher course in refining, something like what the law-school boys go through before taking the bar exam. We won't guarantee you a job for a high score, but maybe you can use it to prove to your boss that you're the man who knows all the answers. As the ads say, combine pleasure and profit.

Seven Million

SEVEN MILLION barrels per day. That's the present rated throughput capacity of refineries in the United States as revealed by the Journal's latest survey.

That's a lot of barrels. It's a figure that would have sounded fantastic only a few years ago, which shows how rapidly the refining industry is growing and changing. Big and little, there are 341 refineries operating currently, and they can be found in all but 11 states. Their locations and a lot of summary information about them can be found in the survey tables starting on page 329 of this issue.

Charter Member

WITH great sadness and reverence we removed from our subscription list the other day the name of G. French Downs of Bartlesville, Okla. He requested this removal because he has retired from Cities Service Oil Co. after more than 50 years in the oil business.

"I have been a reader of The Oil and Gas Journal since its publication," he wrote.

That makes Brother Downs a charter member of the lodge, that select fraternity of Readers of the Big Yellow Book. For, as you should know, the Journal has been in the oil business almost 50 years too. We wish Brother Downs had held on until he got our Golden Anniversary Number next May. It will bring back memories to many an old timer in the business and open the eyes of a lot of comparative youngsters.

Can anyone else in the audience claim to be a charter subscriber? If your history, like ours, goes back to Spindletop, we should have been your favorite oil publication for half a century.

Not Kid Stuff

EXPENSIVE toys is what some people call scale models of refineries and other plants. They look cute and make a nice impression in the front lobby or at an exposition. But they can be put to a lot more practical and money-saving uses, as explained in an article in this issue. Those fancy models of new ships you often see usually weren't made just as a hobby, for we have been told that a shipyard must have a detailed model before the keel is laid in order to be sure that all the parts will fit into the right places, and now the same procedure is being used in building petroleum installations.

Free List

EVER ask yourself "Where did I read that?" or "What was that article on instrumentation?" If it pertains to refining or petrochemistry you can get the answer quickly from a new bibliography which lists all the articles which have been published on these subjects in the Journal during 1948, 1949, and 1950. It's conveniently arranged for quick reference and is the right size for notebooks or file folders. And it's free. Just drop a postcard to our Reader Service Department.

—*Henry D. Ralph*

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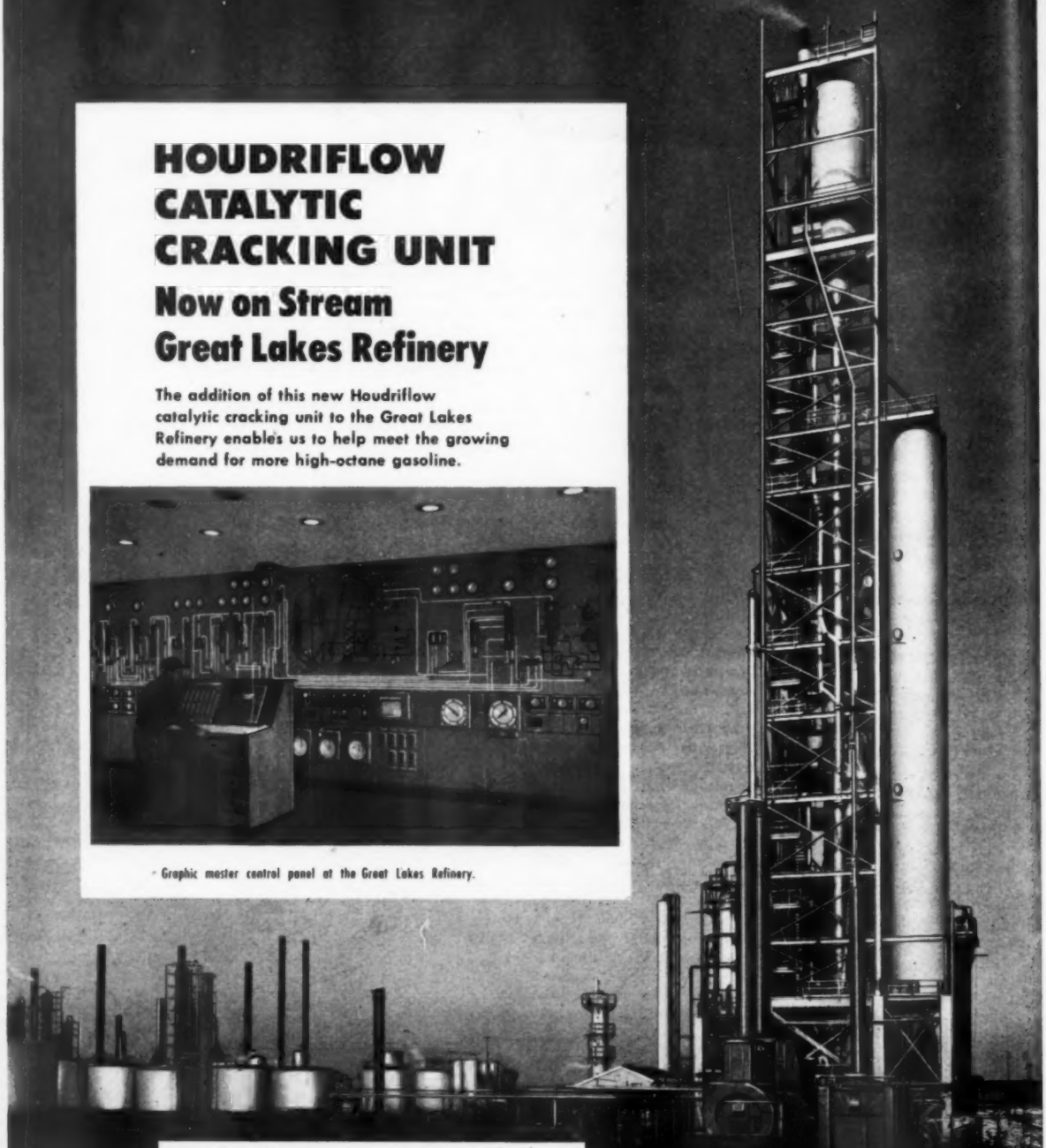

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Job for Refiners

The biggest program of refinery construction in the history of the industry lies in the 2 or 3 years immediately ahead. This is apparent from a glance at readily available statistics on capacity and demand.

First, there is the immediate need for new facilities for petroleum war products and petrochemical specialties such as military-grade aviation gasoline, synthetic-rubber components, benzene, toluene, plastics intermediates, and various others. This chiefly involves augmenting existing refineries by adding facilities for catalytic cracking, reforming, polymerization, alkylation, aromatic concentration, and similar processes.

Second, it is now becoming clear that more basic catalytic cracking capacity will be needed to supply feed stocks for these specialty processes and to keep up with civilian demand for high-octane motor fuel. This will mean a great acceleration of the current trend toward installation of catalytic cracking and reforming facilities at smaller plants.

Third, and most fundamental of all, the industry very soon must have more crude-input capacity—primary distillation—to support all the refining processes which follow. Total rated crude capacity of United States operating refineries is currently just over 7 million barrels daily. During the first quarter of 1951, runs to stills averaged 6,430,000 bbl. daily. This leaves an excess capacity over runs of only 9 per cent, the smallest reserve capacity during the first quarter of any year in the past decade.

Even without military requirements, the demand for petroleum products is increasing rapidly and gives every evidence of continuing to increase. The increase can no longer be met by squeezing a little more through existing equipment. Whole new refineries must be built.

Estimates generally accepted in the industry forecast increases in demand averaging about 200,000 bbl. daily each year for the next 5 years, and this cannot be met without new construction. In addition, something in the neighborhood of 300,000 bbl. of capacity is expected to wear out and be retired during each of the next few years. Thus new basic refining capacity of 500,000 bbl. daily must be built annually in addition to the equipment needed for normal maintenance and replacements in operating plants.

Let no one conclude from this that we are about to "run out of oil" or that refining will soon be a bottleneck. The industry is aware of the problem and has the essential know-how and a complete readiness to meet it without prodding or planning by the Government.

What is needed is money and materials. The industry will find the money if the Government's tax and price policies will let it. Materials are now subject to government control, but at the moment the federal agencies seem fully cognizant of refinery needs. If no new roadblocks are erected, refinery construction will soon hit the highest pace ever.

THIS WEEK

REFINING—Special process section and refresher quiz in this Annual Refining Number. . . . ¶Lummus Co. awarded contract to expand facilities at Pan Am Southern Corp.'s Destrehan, La., refinery in connection with $6,500,000 expansion program to produce aviation gas and jet fuel. . . .

STEEL—PAD confident adequate tubular goods will be supplied to oil and gas industry under NPA's Order M-46, but plans controls to prevent possible black market. . . . ¶Two Texas independent operators blame shortage of pipe on lack of new mill construction, predict shortage will continue until they are built. . . .

WASHINGTON—Administration of accelerated tax amortization under which oil industry has been granted rapid write-off of facilities under investigation by Congress. . . . ¶OPS issues first regulations for oil industry covering retail prices of products. . . . ¶NPA considering possibilities of averting 17,000,000-gal. shortage of benzene by imports from Germany. . . .

TIDELANDS—Senate committee studying views of Departments of Justice and Interior on tidelands-quitclaim legislation preparatory to taking vote which will send it to the Senate floor for action. . . . ¶Federal freeze on gulf tidelands activity means it will take 22 years to pay out investment in oil development. . . .

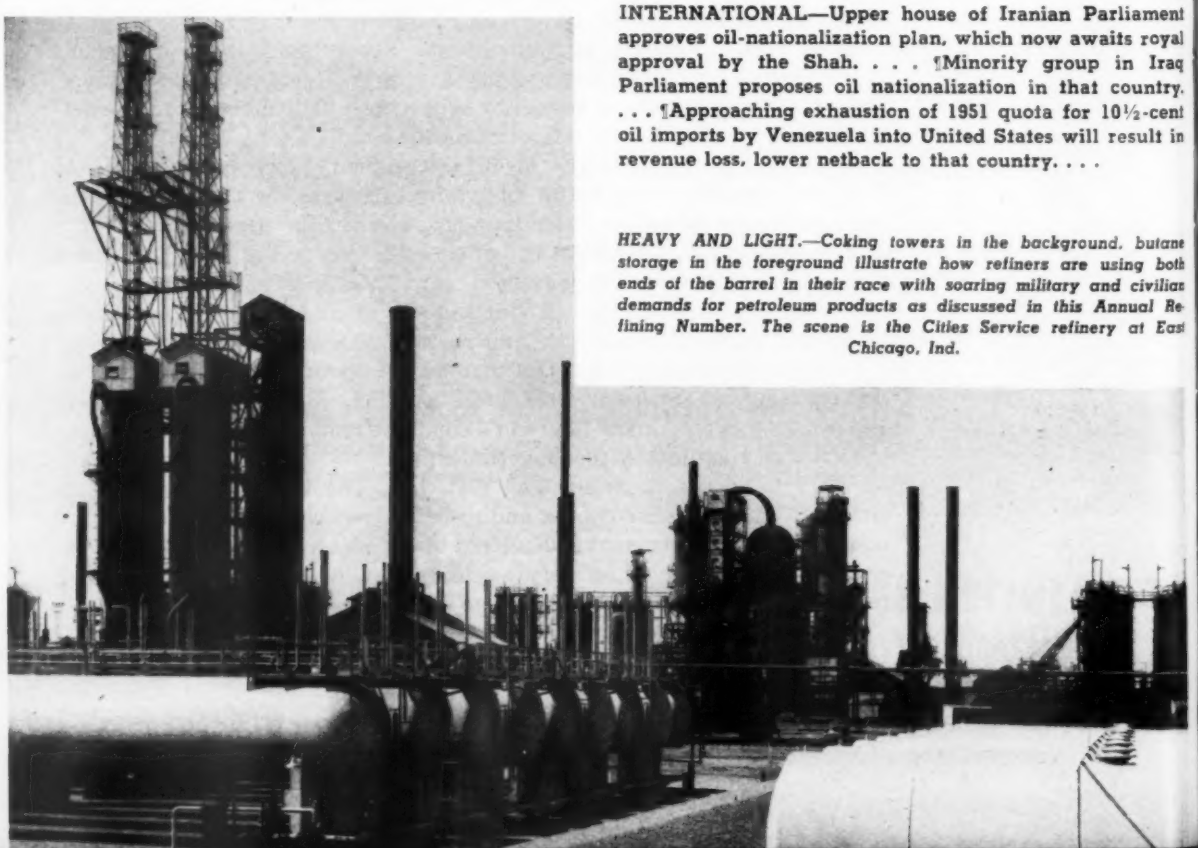
INDUSTRY—Amarillo A.P.I. group looks into new technical advances in drilling, completion, secondary-recovery operations. . . . ¶Paul Kayser of El Paso Natural terms any cut in gas industry's expansion program "unrealistic;" cites importance of fuel for defense program. . . . ¶New Gulf-Michigan Gas Transmission Corp. will build $90,000,000 line from Monroe, La., to Chicago area. . . . ¶Individual producer's role in emergency major topic for discussion at North Texas Oil and Gas Association meeting. . . . ¶Colorado adopts new oil and gas-conservation law. . . .

ACTIVITY—Daily average production of crude for week ended March 24 was 5,962,975 bbl., down 2,200 bbl. from previous week but up 1,186,310 bbl. from same week last year. . . . ¶Total completions increased to 747 wells compared with 721 last year. . . . Wildcat completions totaled 163 wells for the week, an increase of 37 over same week last year. . . . ¶Rotary rigs operating in United States on March 19 decreased 10 rigs for the week to 2,167. . . .

TRENDS—Total primary stocks of major products in United States on March 17 amounted to 236,474,000 bbl., up 2,762,000 bbl. from same date last year. . . . ¶Stocks east of California are up 15,096,000 bbl. . . . ¶Increases in PAW District 2 accounts for 12,156,000 bbl. of the total. . . .

CANADA—Alberta government to permit export of natural gas to Anaconda Copper Mining Co. in Montana, but "purely for defense purposes." . . . ¶Route of all-Canadian crude-oil line from Edmonton to Vancouver approved by House of Commons. . . . ¶Country to begin allocation of TEL April 1. . . .

INTERNATIONAL—Upper house of Iranian Parliament approves oil-nationalization plan, which now awaits royal approval by the Shah. . . . ¶Minority group in Iraq Parliament proposes oil nationalization in that country. . . . ¶Approaching exhaustion of 1951 quota for 10½-cent oil imports by Venezuela into United States will result in revenue loss, lower netback to that country. . . .



HEAVY AND LIGHT.—Coking towers in the background, butane storage in the foreground illustrate how refiners are using both ends of the barrel in their race with soaring military and civilian demands for petroleum products as discussed in this Annual Refining Number. The scene is the Cities Service refinery at East Chicago, Ind.

Tubular-Goods Supply

PAD confident plenty will be provided under NPA's Order M-46, but plans controls to make black market impossible

Bertram F. Linz

WASHINGTON.—Petroleum Administration officials are confident that the tubular-goods supply provided for in the National Production Authority's M-46 order will be adequate to support the oil industry's drilling program but nevertheless are planning controls which will make development of a black market virtually impossible.

At the same time, they are planning to insure the availability of tubular goods to provide for the development of new areas of production found under the wildcatting program for which 5 per cent of mill production of pipe, tubing, and casing will be set aside for distribution through designated supply houses.

Notification promised. — Meanwhile, Deputy Administrator Bruce K. Brown has promised oil and gas operators that they will be notified by April 16 of the action taken by PAD on their applications for priorities assistance in placing orders for oil-country tubular goods for delivery during the third quarter. The inventory and requirements reports on PAD Forms 16 and 17 are due to be filed by March 31, and Brown said that applications so far received (and they are coming in by the sackful) indicate that operators plan to drill oil and gas wells at a rate substantially higher than the 43,400 wells seen by PAD and the industry as the minimum required to meet the combined defense and civilian demand.

Encouragement voiced.—"PAD wishes to encourage the drilling of additional wells, since our calculations show that 43,400 new wells is the minimum number required to provide sufficient productive capacity to meet defense and essential civilian petroleum demands," Brown said. "Nevertheless, it is clear that not enough steel will be available during the next few months to produce the oil-country tubular goods required to meet third-quarter drilling programs as presently planned."

Output drops. — Production of oil-country tubular goods, which averaged about 150,000 tons a month last year, dropped to approximately 130,000 tons during the first quarter of 1951. Brown expressed confidence that NPA will make every effort to assure that enough steel is made available to the mills to enable them to reach the production level of 157,500 tons a month required to support the program, but it may be several months before that figure is reached.

Present indications are that production in April may not exceed 140,000 tons and no estimates can yet be made of May or June output, Brown said, so it will be necessary for operators to supplement their mill orders through the use of material already in stock, second-hand material wherever possible, and the application of steel-conservation measures.

Inventory reports scanned.—The inventory reports now being scanned in PAD show that some companies have substantial amounts of tubular goods on hand, in some instances enough to support their drilling activities for many months, and such operators will get no allocation until their inventories have been reduced to what PAD considers a proper working stock.

With a number of operators thus out of the picture temporarily, Richard D. Lawton, director of production, expressed the belief the mill production now foreseen will be sufficient to keep drilling operations going without curtailment.

In addition, Lawton pointed out, the inventory reports do not call for information on stocks of used material and the M-48 order imposes no restrictions on the acquisition or use of either second-hand or imported tubular goods. In effect, this is a bonus for operators who can get such material and is encouraged by PAD because it will permit the drilling of additional wells.

To block black market.—PAD officials believe that the relatively easy tubular-goods situation will discourage the development of a black market but are determined to take positive steps to assure that all steel allocated to operators is used for the purposes outlined in their applications.

Such steps might include a requirement that operators submit documented reports of their drilling operations or some other form of proof that material was being used properly.

Officials also are giving assurance that in the allocation of material the "little businessmen" who in this industry account for the great proportion of new discoveries, will be adequately cared for, as required under the Defense Production Act.

Form PAD-21.—PAD also is taking steps to work out a program for machinery and equipment for production and last week distributed to the nearly 500 manufacturers of such items a form, PAD-21, on which to report on products shipped during the first quarter, unfilled orders as of March 31, shipments to be made during June and during the second and third quarters, quantities of metals used during the first quarter, metal inventories as of March 31, estimated requirements during June and during the second and third quarters, and estimated needs for major components, such as engines and motors for pumping units.

Deadline near. — Manufacturers' reports are to be filed by March 31, a separate report for each plant, quick response being necessary because of the shortening time in which to work out a program for inclusion in the controlled-materials plan which is to go into effect July 1. Under the agreement between PAD and the National Production Authority of last January 15, the former is to be responsible for production and distribution of machinery and equipment for production.

The projected machinery and equipment program will complement the tubular-goods program embodied in the NPA M-46 order and is essential to insure the drilling of the 43,400 wells planned for this year, it was explained by Deputy Administrator Brown.

"The rate at which oil and gas wells are drilled depends, for example, on the rate at which rotary rock bits are manufactured and delivered for drilling operations," Brown pointed out. "Wells which no longer produce through natural forces can be made to produce by mechanical methods, but only if adequate supplies of pumping units and sucker rods are available to operators.

Difficulties noted.—"Many of the companies which manufacture or fabricate machinery and equipment for oil and gas production have been having serious difficulties during recent months in obtaining materials. Reports to PAD show that some have been able to acquire only a small proportion of the materials they have used in the past.

"It is of the utmost importance that steps be taken as quickly as possible to bring materials supplies for these companies into balance with demands," Brown asserted. "After the information we have requested has been obtained, however, it will take some time for PAD, working in cooperation with the NPA, to develop a workable program for equitable distribution of needed materials."

In the meantime, Brown said, PAD will continue to serve as a central

point of contact with the Government for manufacturers and fabricators and will give what spot assistance it can in dealing with the materials problems of individual concerns.

Another questionnaire, dealing with drill pipe, is expected to be sent out by PAD this week.

Amortization Inquiry

Congress may try to cut accelerated-tax program

WASHINGTON.—Administration of the accelerated-tax-amortization provisions of the Revenue Act of 1950, under which the oil industry thus far has been granted rapid write-off of facilities to cost $104,100,000, is under investigation by Congress.

Soon to be called upon to increase income and other taxes, members of Congress fear that accelerated amortization may become a device for the avoidance of high emergency-period corporation taxes. So serious is the matter considered that five congressional committees are carrying on investigations simultaneously.

Under the accelerated-amortization program, the cost of new defense facilities may be written off in 5 years instead of the normal 15 or 20-year period. Some 4,150 applications for certificates of necessity have been filed so far covering facilities to cost $11,500,000,000, and 585 applications have been approved on expansions to cost approximately $3,500,000,000 for rapid write-off of some $2,550,000,000.

Encourages expansion.—The amortization program is designed to encourage the construction of facilities for production needed for defense or defense-supporting programs. The certificates, which on the average are for approximately 74 per cent of their costs, are supposed to take into consideration the value of the new plants for civilian production after the end of the defense period.

No criticism has yet been voiced over the certificates granted the oil industry, but questions have been raised regarding the propriety of 85 per cent grants for the construction of steel plants, which have a life of up to 40 or 50 years and many of which would, it is contended, have to be built anyway to take care of increasing civilian demand.

Estimate inflated.—The congressional committees also have raised the possibility that estimates of the cost of new facilities may have been greatly inflated in applications, and officials of the Defense Production Administration, which is administering the program, admit they are unable to check back on applications to make sure that estimates are proper. They concede the possibility that an applicant, knowing he will not get 100 per cent amortization and seeking to get as much as he can, may inflate his estimates with the result that, if he gets a certificate for 75 per cent of the cost of a new facility estimated at $1,000,000 and the actual cost turns out to be $750,000, he actually gets a quick write-off of 100 per cent.

Treasury loses. — The $2,550,000,000 already made eligible for accelerated amortization means that the Treasury stands to lose the taxes on some $500,000,000 of corporation income annually over the 5-year period and Congress is fearful that unless some curbs are imposed the tax-exempt sum may reach several times that amount, possibly as much as $7,000,000,000 if all current applications are granted.

Benzene Imports

Germany may offer a way to beat growing shortage

WASHINGTON. — Possibilities of averting a 17,000,000-gal. shortage of benzene this year by importations from Germany are under consideration in the National Production Authority.

Western Germany, a benzene-industry advisory committee (of which C. B. Lane, Standard Oil Co. of California, New York, is a member) advised the NPA, is producing 9,000 metric tons a month which is being used for the improvement of motor fuel and the benzene industry here has been unsuccessful in attempts to negotiate a deal which would bring any of it to the United States.

Benzol conversion. — The conversion of German-produced benzol to benzene would result in about 2,000,000 gal. of benzene a month, sufficient to meet the indicated deficit in domestic supply, and the industry has suggested that an effort be made to secure an agreement for the exchange of "fuel-blending medium" for the German product.

A task-force study developed that military and defense-supporting needs will add 30,000,000 gal. to the 222,000,000 gal. of benzene which normally would be used this year, making total 1951 requirements 252,000,000 gal. Against this, there is a foreseeable supply of 25,000,000 gal. from petroleum, 170,000,000 gal, from coke-oven operations, and 40,000,000 gal. from imports, a total of 235,000,000 gal.

Above normal.—The anticipated imports are materially above normal and reflect a price rise which has brought out supplies located at distances from the seaports. The main exporting countries are England, Belgium, Holland, and Canada.

Industry representatives told NPA the situation has not yet developed to a point where allocation of benzene would be justified, but the impact of defense orders is beginning to be felt and if no arrangement can be made with Germany or other expedient developed to fill the gap between supply and demand, some controls on distribution may be necessary in the future.

At the same time, they asserted, delay in issuing certificates of necessity to producers planning to expand and build new facilities for benzene production is tending to slow down the program for expansion of output.

OPS Order

Agency issues regulation governing product prices

WASHINGTON. — The Office of Price Stabilization has issued the first of a series of tailored regulations for the oil industry, covering the retail prices of gasoline, lubricating oils and greases, kerosine, gear oils, naphthas and solvents, liquefied petroleum gas, and all distillate burning, heating, and fuel oils.

The order embodies the policy which is expected to be applied in other regulations setting ceilings for crude and products at various levels of the industry, authorizing retailers to fix their prices on a basis which will reflect the normal cost-price relationship generally in existence prior to the Korean invasion.

Ceiling set.—In general, the regulation establishes as the ceiling for the products covered the highest price charged for each grade of products during the base period December 19 to January 25. It allows the base-period margin for retail dealers, but permits a maximum margin of 4 cents a gallon for gasoline in areas where, because of price wars, dealers were caught by the general freeze order of January 26 with lower than customary margins.

If pricing on the December-January base is extended to refiners it will differ from the policy which is being considered in connection with an order on manufacturers' pricing which is to be issued by OPS, which would base prices on the preKorean level plus such increases in costs of raw materials and labor in the production process as may since have occurred.

May be temporary.—The retail and other orders now being put into effect may be only temporary in nature, later to be superseded by regulations providing dollar-and-cents ceiling prices—the system followed by the Office of Price Administration during the war.

Both the retail regulations and those to follow for crude, asphalts, lubricating oils and greases, and wholesalers will permit price increases in some instances as adjustments but

WATCHING WASHINGTON

Bertram F. Linz

Pipe Output Slipping

An accelerating downward trend in the production of line pipe threatens serious disruption of oil and gas pipe-line construction, and an urgent appeal has been made to the National Production Authority to freeze production at the current rate.

The downward trend in output evidenced itself in the last quarter of 1950 when production proved to be 39 per cent under that of the preceding two quarters. Figures for the first quarter of this year are not yet available, but it is believed a further drop will be recorded.

As a result, pipe-line-construction schedules have been seriously set back from 3 to 12 months. Some mills have rescheduled for delivery in the second quarter orders placed for delivery in the first quarter, and extreme cases have been reported where orders originally scheduled for delivery in the second quarter of this year will not be filled until the second quarter of 1952. Some of the mills furnishing small-diameter line pipe on an allotment basis, it is reported, have reduced allotments as much as 40 per cent within the past 6 months.

The pipe-mill operators assert that the situation is due to directives to furnish steel for other programs such as the railroad-freight-car and ore-boat programs which are taking steel plate that normally would come to them. One instance has been reported where only 20,000 tons of plate was made available to a pipe mill which has a capacity of 60,000 tons a month.

While present pipe output is far below what is needed to carry out the scheduled operations of the oil and gas industry, it is hoped that it will get a better break under the controlled-materials plan now in the making. In the meantime, NPA has been told, it is essential that pipe production be prevented from slipping further.

Moral and a Lesson

There's a moral and a lesson somewhere in the story of an emergency agency set up in 1932 for 1 year which kept on going for the next 18 years and finally erupted in a congressional investigation furbished by such juicy morsels as a mink coat for a White House stenographer, free lodging for government officials at a swanky Florida hotel, and loans to companies, including one oil organization, which went into receivership after they got the money.

The agency, of course, is the Reconstruction Finance Corp., which, among other things, manages the Government's synthetic-rubber-production program. In the past it has made loans for all sorts of purposes, including the purchase of a barber chair.

A year ago a Senate committee investigated the Texmass loan and the way it was handled and didn't think much of what it found; it also went into the Hydrocol loan, and recent investigation again touched upon that matter.

The RFC was set up to give aid to enterprises which couldn't raise credit anywhere else and so its operations entailed greater risks than are taken by other lending institutions. That was not the basis of complaint—what was is the aura of political loans, White House influence, attempts to cover up.

The moral and lesson may be that it isn't in the best interest of the country to set up governmental corporations exempt from the audits and checks designed to keep federal agencies in line and able to surround themselves by a secrecy which even Congress found it hard to crack.

Japs' Synthetic Efforts

Japan's search for new oil resources during World War II as our naval forces whittled down its supply lines from the East Indies became so frantic that efforts were made to produce oil even from such materials as orange peels, rubber, and pine needles, it is disclosed in a report just prepared by the Bureau of Mines from a study of Japanese documents secured after Japan's defeat in 1945.

The Japanese did build and operate plants for producing synthetic-liquid fuels by various means, including coal hydrogenation, which had been studied more intensively in Japan than in any country except Great Britain and Germany, but they were never able to bridge the gap between supply and war needs.

Synthetic production reached its peak in 1944, but even then amounted to only 955,000 bbl., Japanese records disclosed. Of this, 899,970 bbl. was produced by low-temperature carbonization of coal, a process from which coke is the main product and liquid fuel a byproduct, with another 149,250 bbl. from the Fischer-Tropsch gas-synthesis process and only 5,780 bbl. from coal hydrogenation.

will not allow for any general price raise, officials said.

The margin provisions of the order were based on figures furnished by the American Petroleum Institute showing that 4 cents was the lowest margin existing during the base period in 50 representative cities, but OPS said the figure is only tentative.

Agency Orders Issued

WASHINGTON.—The following orders have been issued by national defense agencies:

Office of Price Stabilization:

Ceiling-Price Regulation 13, March 21: Fixing retail ceilings on petroleum products.

National Production Authority:

Order M-49, March 15: Providing for the allocation of columbium and tantalum.

Amendment to Order M-3, March 15: Regulating the distribution of DO-rated orders for columbium and tantalum-bearing steels.

Amendment to Order M-19: March 16: Making cadmium available for certain essential civilian products.

Amendment to Order M-36, March 21: Permitting printing firms having Government Printing Office contracts to order paper stock from special reserves.

Amendment to Order M-17, March 23: Limiting defense-rated orders required to be accepted by manufacturers of rigid electrical conduit.

Oil-Well-Supply Sales Up

WASHINGTON.—Sales of independent oil-well-supply houses reached a total of $718,051,000 in 1948, almost exactly four times the 1939 sales of $179,770,000, it has been reported by the Census Bureau.

The bureau's figures were based on returns from 1,027 establishments which did not include distributors selling such equipment as secondary lines or the sales branches and offices of manufacturers. The number of independent suppliers was 131 greater than in 1939, and the average sales volume was $699,000 in 1948 against $201,000 in the earlier year.

The reporting establishments had an inventory at the end of the year valued, at cost, at $102,217,000 against $31,318,000.

The bureau reported that 82 per cent of the total dollar volume of trade was recorded in the six states of Texas, Oklahoma, California, Louisiana, Kansas, and Illinois. The 344 establishments in Texas reported sales of $277,820,000; Oklahoma's 129 establishments reported $93,362,000; California had 137 establishments with sales of $85,632,000; Louisiana, 80 establishments with sales of $65,957,000; Kansas, 62 establishments with sales of $36,353,000, and Illinois, 45 establishments with sales of $27,801,000.

A.P.I. OFFICERS AND CITATION RECIPIENTS.—Newly elected officers of the division of production, Mid-Continent district, American Petroleum Institute, are shown at left. Sitting: Fred J. Neslage, A.P.I. Panhandle chapter chairman and a host; Harold E. Berg, district chairman, Tulsa; and Glenn M. Stearns, new chairman of the district-advisory committee, Tulsa. Standing: V. J. Mercier, secretary-treasurer, Wichita; and Vern Morris, vice chairman for southwestern Oklahoma, Pauls Valley. At right are recipients (or their representatives) of citations for exceptional service rendered during the past years. Sitting: H. E. Zoller, Derby Oil Co., Wichita; L. A. Ogden, Pure Oil Co., Tulsa; Harold S. Kelly, Phillips Petroleum Co., Bartlesville, Okla.; William L. Horner, Sunray Oil Corp., Tulsa. Standing: Harold E. Berg, representing W. E. Best, consulting engineer, Pauls Valley, Okla.; and George C. Howard, representing Lloyd E. Elkins, Stanolind Oil & Gas Co., Tulsa. R. C. Kay, independent operator, Amarillo, also received a citation.

New Techniques Studied

Advances in methods of drilling, completion, secondary recovery dominate discussions at Amarillo A.P.I. meeting

Roy F. Carlson

AMARILLO.—Advances in the techniques of drilling, completion, and secondary recovery dominated the discussions at the technical sessions of the Mid-Continent meeting of the American Petroleum Institute Production Division here March 21-23, one of the largest district meetings in the Institute's history.

There was particular interest in a report on "Straight-Hole Drilling in Crooked-Hole Country," which described results of study by an A.P.I. committee on bore-hole drift in the Mid-Continent area. Use of oversized drill collars was described as a partial success in maintaining a straight hole.

Another partial solution to the problem, suggested by the authors, G. C. MacDonald, Gulf Oil Corp., and Arthur Lubinski, Stanolind Oil & Gas Co., is to maintain the weight on the drilling bit below levels that will tend to buckle the drill pipe or collars, and cause the hole to deviate from the straight path. This second solution, the authors said, will require modifications in bit design and in existing weight indicators. Use of stabilizers will also help maintain a straight hole, they suggested, but in the past most stabilizers or reamers have not been placed in the proper point in the drilling string.

Decline curves.—A paper prepared by John F. Buckwalter of Ryder Scott Co. showed that decline curves are a valuable tool for use in predicting recoveries of oil by secondary waterflooding methods. Also, the shape of the various kinds of curves that can be plotted will give an indication of permeability distribution in a reservoir. But decline curves are of little use, the author said, if oil production is prorated or restricted in any way, because adequate and constant water-injection rates must be maintained in the reservoir, and production must be open. If proper injection and production practices are maintained, several kinds of curves are available to effectively mirror any changes in operating a field, and will illustrate a large variety of information such as ultimate recovery and relative efficiency of operation.

Close spacing.—By using five Oklahoma fields as examples, George R. Elliot of Phillips Petroleum Co. supported the contention that wells are being drilled in fields today on a much closer spacing pattern than is necessary to obtain maximum recovery from an oil reservoir. A well that had established a decline trend was taken in each of these fields, and each showed a distinct break downward from the trend as additional wells were completed in its vicinity, the author's opinion being that the newer wells interrupted an established flow pattern in the reservoir, taking oil that would have been displaced into the older well.

Hydrafrac. — Operators considering treatment of a well with Hydrafrac should consider many factors besides lack of production, including permeability, nature of reservoir energy, production history, work over history, formation characteristics such as total and effective thickness and existence of shale breaks if any, condition of the equipment in a well, including tubing, casing, and well head.

Some of the general considerations suggested by Joe W. Maly and Tom E. Morton, Halliburton Oil Well Cementing Co., authors of the paper, are that shale will probably part easier than other formations, long sections are more difficult to treat than short ones, that exceptionally high permeability pays cannot be aided materially, and that solution-gas drive reservoirs have so far produced the best results after treatment with Hydra-

frac. The authors said that setting pipe through the pay and then treating through perforations appears to be the most successful method of treating a pay horizon.

Electric logs. — Sylvain J. Pirson, Stanolind Oil & Gas Co., reviewed methods of electric-log interpretation. The spontaneous potential curve, he said, will indirectly permit an evaluation of formation-water salinity, the short-investigation resistivity curve will permit an evaluation of formation porosity in per cent by responding to mud filtrate in an invaded porous formation close to the well bore, and the long-investigation resistivity curve will give an indication of true formation resistivity and therefore permit evaluation of connate water saturation and productivity of a pay zone.

Salt slurry.—Additions of salt to the mixing water while preparing oil-well cement slurries will decrease thickening time for cements up to 300,000 parts per million, according to N. C. Ludwig of Universal Atlas Cement Co. Over that quantity, the setting times were longer except in the retarded kind of cement. Compressive strength of ordinary cement increased up to a concentration of 30,000 p.p.m. of salt and then decreased, while retarded cements had an increasing compressive strength up to concentrations of 100,000 p.p.m.

Pump beams.—A review of methods used to determine proper counterbalance for beam pumping units, by Douglas O. Johnson of Johnson-Fagg Engineering Co., suggested that more careful attention be given to counterbalancing since pumping units are now being built closer to specifications of load than before. The author suggested the use of a dynamometer in conjunction with a timing device and a tachometer to properly evaluate counterbalance and measure peak torque to check on whether or not the machine is overloaded.

Acidizing.—Recent developments and techniques in acidizing, with particular reference to such uses in oil-bearing horizons that are partly composed of silicate minerals that swell under the influence of acid, were reviewed by P. H. Cardwell of Dowell Incorporated. The swelling of these minerals has been controlled by addition of agents to the acid before it is put into the well and, according to the author, has resulted in a greater increase in production, a smaller amount of emulsion being formed, a shorter period of time for the oil to become pipe-line quality, and an easier return of the spent acid from the formation.

These results come about, the author said, because the amount of acid is lessened, resulting in less insoluble materials being released into the formation permeability, and less water being put into the well with the acid originally.

Water flood.—A report of the progress of a water flood in Hildreth pool of Montague County, North Texas, was delivered by Chester Brown, Continental Oil Co. This pool underwent a gas injection program which began in 1944 and which was terminated in 1950. The present water-injection plan was begun in early 1948, and is continuing at the present time. Although only a small part of the reservoir has been affected by the flood, a definite increase in production has evidenced itself.

Cement tests.—J. B. Roberts of Lone Star Cement Corp. reviewed developments in recent work on the A.P.I.'s Code 32 by members of the Mid-Continent district committee for reviewing these cements. Roberts described various testing apparatus, the results derived from this equipment, and the advantages, disadvantages, and limitations of each kind of testing tool.

Drill collars.—A paper presented by R. J. Stoup of National Supply Co. minimized the importance of exact control of chemical constitution of various steels used in drill-collar manufacture. Stoup reviewed various manufacturing processes used to produce drill collars when other methods, particularly seamless piercing, would produce an equivalent or perhaps better drill collar. He added that particular care should be taken to obtain a fine-grained structure in steels and this can best be achieved by rapid quenching of the heated drill collar. And in addition to the metallurgical properties of the steel, Stoup insisted that the collars have the proper care in the field, and that attention be given to maintaining the proper kind of joint and joint fit and balance during the life of the collar.

Depletion.—E. D. Thompson, senior member of the Texas Railroad Commission, was featured speaker at the association banquet. His recent testimony before a congressional committee on the 27½ per cent depletion allowance furnished the bulk of his address. Thompson said, "The depletion recognition does not guarantee to any oil operator that he will find oil. He just gets a hunting license to search for oil."

Citations.—Seven "Citations for Service" were presented to A.P.I. past committee chairmen in the Mid-Continent region: Lloyd E. Elkins, Stanoline Oil & Gas Co., Tulsa; Harold S. Kelly, Phillips Petroleum Co., Bartlesville, Okla.; William L. Horner, Sunray Oil Corp., Tulsa; H. E. Zoller, Derby Oil Co., Wichita; R. C. Kay, independent operator, Amarillo; W. E. Best, consulting engineer, Pauls Valley, Okla.; L. A. Ogden, Pure Oil Co., Tulsa.

Officers.—New Mid-Continent district officers elected were: District chairman, Harold E. Berg, Tide Water Associated Oil Co., Tulsa; vice chairmen for northeastern Oklahoma, F. J. Wilbanks, Bethlehem Supply Co., Seminole, Okla.; for southwestern Oklahoma, Verne Moore, Sohio Petroleum Co., Pauls Valley; for Kansas, W. D. Maxwell, Carter Oil Co., Great Bend, Kans, (reelected); for the Texas Panhandle, J. Max Harbison, Kewanee Oil Co., Pampa, Tex.; for Illinois-Indiana, T. C. Stauffer, Sun Oil Co., Evansville, Ind.; secretary-treasurer, V. J. Mercier, Perforating Guns Atlas Corp., Wichita; advisory - committee chairman, Glenn M. Stearns, British-American Oil Producing Corp., Tulsa.

Wichita was selected tentatively as site for next year's district meeting, according to C. A. Young, A.P.I. production-division director.

Gas' Importance Cited

Kayser terms any suggestions to cut fuel's expansion as "unrealistic" and stresses its value to defense program

Roy F. Carlson

AMARILLO.—Natural gas is intimately related to defense production and maintenance of the national economy at a high level, and suggestions to curtail its expansion at this time are unrealistic, the A.P.I. Mid-Continent meeting here was told by Paul Kayser, president of El Paso Natural Gas Co.

He pointed to the essentiality of gas to the production of such vital materials as copper, potash, chemicals, steel, aluminum, and to the actual training of fighting troops. That it is important to the maintenance of the economy at a high level he illustrated by pointing to natural gas as furnishing 18.7 per cent of the energy consumed in the United States in 1950, and by the increased utility sales of natural gas since the beginning of World War II—more than double in 1950 what they were in 1941.

Kayser commended the part that natural gas has been given in the national-defense program, and the organization that has been set up to administer this effort. Regarding efforts of representatives of the coal industry to have the Government place restrictions upon the uses of oil and gas, Kayser had this to say:

Supply. — "There are approximately 30 years' proven reserves of natural gas to support the present rate of

consumption of gas in this country but the rate of discovery of reserves exceeds consumption each year by more than double the consumption. So long as this continues there is no occasion to be concerned about the exhaustion of reserves, and there is no necessity to construct or put in operation plants for the production of synthetic high-B.t.u. gas from either coal or oil shale.

"The natural-gas industry has been accused by some of its opponents of having displaced other fuels and therefore disrupted the national economy by substituting a natural resource with a more limited life than the one displaced and from this they have reasoned that expansion of the natural-gas industry should be curbed in the interest of stability of our economy."

Transportation. — In answer Kayser said, "By taking present freight rates for coal and present costs of transporting gas by large-diameter pipe lines, it can be demonstrated that transportation of coal by railroad is the most inefficient method of transportation of a unit of energy, and that the most efficient method is transportation of oil in high-pressure pipe lines with transportation of gas by the same method next in line.

"Another factor to be considered is that a great number of the country's pipe lines traverse existing coal areas, and could easily be connected with the gas-producing plants at the mouth of mines. At such time in the far distant future when the gas reserves are depleted, a transportation system greatly expanded over the present system will already be in existence for the transportation of gases manufactured from coal."

Future.—Coal producers, Kayser said, have pointed out that petroleum and natural gas have changed our entire economy into a "mobile" one, and that because of this we should restrict the further expansion of the use of petroleum and natural gas and conserve them for these special uses.

"But," Kayser said, "by using these resources of oil and gas, instead of hoarding them, we will have a system so developed that when these resources are exhausted we will be able to substitute in their place the synthetic fuels made from coal and shale, and therefore maintain for the maximum time our high standard of living."

New Gas Line Planned

Gulf-Michigan Gas Transmission to build $90,000,000 700-mile 30-in. line from Monroe, La., to Chicago area

Paul Reed

A NEW pipe-line firm, Gulf-Michigan Gas Transmission Corp., of St. Louis, has been formed to construct a $90,000,000, 700-mile, 30-in. natural-gas line from Monroe, La., to Michigan City, Ind. An application is expected to be filed with the Federal Power Commission at the end of this week seeking the project's approval.

Initial capacity of the line, to serve the Chicago area, will be from 350,000,000 to 400,000,000 cu. ft. of gas daily, and ultimate capacity will reach 600,000,000 cu. ft. daily. The firm will begin to receive pipe for the line in January 1952 and the project is scheduled for completion the latter part of that year.

Officers.—William G. Marbury, president of Gulf-Michigan, is also president of Mississippi River Fuel Corp., which has a prominent position in the stock ownership of the new firm and will furnish it with top office personnel. Stupp Brothers Bridge & Iron Corp., and other interests will participate in Gulf-Michigan.

E. P. Kramer, vice president and manager of Gulf-Michigan, will direct a staff including an engineering department to be drawn largely from Mississippi River Fuel. Offices of the new firm will be located at 407 North Eighth Street, St. Louis, in the same building with Mississippi River Fuel. Kramer was consultant with Ebasco Services prior to being assistant to the president of Mississippi River Fuel in the last 3 years.

To use United's reserves.—Gas is to be transmitted from Monroe connections with United Gas Pipe Line Co. to Michigan City connections of Michigan-Wisconsin Pipe Line Co. Since the gas to be furnished to Gulf-Michigan will come from reserves dedicated to United Gas interests, gas reserves will not be specified in the application to FPC.

Pipe is on order with A. O. Smith Corp. of Texas. Since pipe laying will commence in January 1952, contracts for pipe laying are due to be let late this year.

Compressor stations. — The number and size of compressor stations will not be definitely determined until plans are completed for deliveries at points along the route. Compressor units will be of the reciprocating type. Mississippi River Fuel has conducted pioneering tests of the internal gas-combustion centrifugal - compressor principle which have influenced the decision to utilize conventional compressor equipment.

Gas will be furnished to Laclede Gas Co. and Illinois Power Co. in the St. Louis area in amounts less than the 200,000,000 cu. ft. to be delivered to Michigan-Wisconsin at the end of the line.

Contract signed.—In announcing the signing of the contract for purchase of 200,000,000 cu. ft. daily from Gulf-Michigan by Michigan - Wisconsin, William G. Woolfolk, chairman of American Natural Gas Co., said that on completion of the Gulf-Michigan line the systems affiliated with American Natural will be able to deliver to its customers more than a billion cubic feet during periods of peak demand.

Michigan-Wisconsin, a subsidiary of American Natural, will deliver to the latter's affiliates and to nonaffiliated companies. The Michigan-Wisconsin system was completed from Texas to Wisconsin 16 months ago with a capacity of 303,000,000 cu. ft. daily.

Michigan Consolidated Gas Co., a subsidiary of American Natural, will receive gas for delivery in Detroit, Ann Arbor, Ypsilanti, Muskegon, and Grand Rapids, Mich. Milwaukee Gas Light Co., also a subsidiary, will receive gas for distribution in the Milwaukee area.

Other service.—The new Gulf-Michigan line will also increase the gas supply to 9 nonaffiliated utility companies who receive gas from Michigan-Wisconsin for distribution in 46 communities in Wisconsin and Michigan. Cities served include Madison, Racine, Kenosha, Green Bay, Kohler, and Sheboygan, Wis.; and Benton Harbor, Grand Haven, Holland, Dowagiac, and Niles, Mich.

Warren Supports PAD Plan

Full support of the materials-distribution plan designed by the Petroleum Administration for Defense was given by J. Ed Warren, president of the Independent Petroleum Association of America, in an address before the Tulsa Chamber of Commerce last week.

Failure of the plan, Warren said, could "very easily result in selective drilling and controls that would restrict the freedom and flexibility from which the industry has drawn its great strength."

Warren also lauded PAD's avowed purpose, as stated by Bruce K. Brown, to secure that degree of mobilization required of the oil and gas industries for the purposes of the present program with as little regimentation as possible and to rely on the industry's integrity and self-interest to prompt it to discharge its functions under the defense program.

The deputy petroleum administrator's statement, Warren said, is both an opportunity and a challenge. If the industry takes this procedure in stride despite its handicaps, the fundamentals of competitive enterprise and technological growth that has created the present ability of the oil industry will be preserved.

Independents' Problems

Individual producer's role in emergency, his problems highlight North Texas Oil and Gas Association meeting

Roy F. Carlson

WICHITA FALLS. — The problems of the independent oil producer and his role in the current emergency occupied most of the sessions of the twenty-first annual meeting of the North Texas Oil and Gas Association here last week. Speakers included tax experts, government counselors, engineers, and government officials.

Beginning sessions of the meeting heard quick reviews of progress in secondary-recovery projects in North Texas.

I. E. Curtis, Hull-Silk Repressuring Association, Wichita Falls, described repressuring results in Hull-Silk field in two different zones as being partly successful. The higher of the two pays, what is termed the 3,800-ft. sand, has responded well, but the lower one has not shown as good results.

Results described.—Much better results from a secondary project were described by W. H. Bowie, Magnolia Petroleum Co., Electra, Tex., in a paper on results of water flooding West Burkburnett field. A pilot-flood operation in this field after 3 years of fillup time has shown increases from 40 to several hundred barrels per day. This pilot area produced 600,000 bbl. during its primary life, and has produced 500,000 bbl. since the flood became effective.

The beginnings of a water flood in K.M.A. field were described as showing some small increases in production. According to W. C. Krog, petroleum engineer for Wayne Hammon, the project is too young to show any definite results. This project is in an area of 145 wells, on about 3,300 acres.

Partnership operation. — Dr. Herman H. Kaveler, Phillips Petroleum Co., Bartlesville, Okla., asked operators to extend the principle of partnership operation of leases to embrace the operation of entire pools. Only by doing this, he said, can pressure-maintenance projects be started early in the life of a field when they will do the most good toward recovering a maximum amount of oil.

Dr. C. W. Seibel, director of Region 6 for the Bureau of Mines, described activities of Region 6, including helium production, search for new metal supplies, study of the thermodynamics of hydrocarbons, and high-pressure high-temperature studies.

Tubular goods.—A scheduled talk by Bryan W. Payne, president of Iowa-Payne Oil Co., and an unscheduled address by Jerry Vinson, Industrial Supply Co., and member of the National Production Authority advisory committee on oil-country tubular goods, reviewed the recent governmental tubular-goods-allocation program. Shortages of pipe were partly blamed on a lack of construction of new mills for producing pipe, and a prediction was made that pipe would be in short supply in any event until new mills were constructed, probably 2 years from now. Vinson asked for suggestions on how pipe should be allocated.

Cooperation urged.—Olin Culberson, chairman of the Texas Railroad Commission, asked for complete cooperation between industry and government during the current crisis, and pledged the support of the commission in obtaining enough petroleum for the emergency. He added that when the period of controls and restrictions is brought to an end, the commission will be foremost in helping to shake off the controls. State Senator Moffet, Chillicothe, Tex., said that oil men, paying about $100,000,000 in taxes to the State of Texas, should become more active in state affairs and government.

Reserve warning.—Gen. E. O. Thompson, senior member of the Texas Railroad Commission, warned that the country is dangerously low in reserve producing ability. He said that the United States probably cannot produce more than 600,000 bbl. per day more than it is now producing. About 335,000 bbl. per day of this excess capacity is in Texas. At the beginning of World War II, Thompson said, we had an excess capacity of 25 per cent of the then-current allowable and now we have but about 10 per cent. Imports, he said, are at about 1,000,000 bbl. per day and if these were cut off we would be about 400,000 bbl. per day short. He urged that the present depletion recognition be maintained to help increase the amount of reserve producing capacity.

"When World War II came upon us," the commissioner reviewed, "we were producing 4,000,000 bbl. a day and had a million barrels daily reserve-producing ability. Before the war was over, we were producing 5,000,000 bbl. a day and had to have severe gasoline rationing to get by. We had to produce a lot of our wells and fields beyond their maximum efficient rate.

"We are going to have to drill twice as many wells in the United States this year," Thompson warned, "if we are to keep up with the constantly growing demands even of our expanding peacetime economy, much less provide for wartime needs should war come."

The commissioner explained the necessity of devising "ways and means of spreading the steel for these more than 44,000 wells over more ground and spread our wells farther apart and drill up our fields through fewer wells through unitization."

SUSTAINED TEXAS CRUDE-OIL-RESERVE PRODUCING CAPACITY
(Comparison with March 17, 1951 Allowable)

District—	Daily average bbl.
Dist. 1 (Southwest	1,534
Dist. 2 (Southwest)	28,877
Dist. 3 (Gulf Coast)	71,306
Dist. 4 (Southwest)	26,141
Dist. 5 (E. Central)	10,093
Dist. 6 (Outside E. T.)	12,278
Dist. 6 (E. T. field)	9,540
Dist. 7-B (W. Central)	6,385
Dist. 7-C (W. Central)	9,475
Dist. 8 (W. Texas)	150,512
Dist. 9 (N. Texas)	9,383
Dist. 10 (Panhandle)	13
Total	335,537

Luncheon meetings.—Luncheon meetings of the association were given a review of the Texas school program by Bascom B. Hayes, head of the Division of Administrative Services of the State Department of Education. William J. Murray, the third member of the Railroad Commission at the meeting, told a luncheon of directors of the association that the country is in dire need of more oil wells and more producing capacity. Dr. George Fancher, head of the Texas Petroleum Research Committee which is now reviewing Texas' secondary-oil reserves, urged that this committee be made permanent. The committee, he said, is doing a great job for Texas and for the oil industry.

M. E. McCULLOUGH

EUGENE B. CLARK

Banquet speakers.—The association's annual banquet, attended by about 1,000 members and guests, was addressed by Bernard L. Majewski, vice president of Deep Rock Oil Corp., and R. B. Anderson, president of the Texas Mid-Continent Oil and Gas Association. Majewski warned against the

spread of communism, and against the danger of Russia's being successful in forcing the United States into spending itself into helplessness. Russia, he said, now has control of one-quarter of the world's population and one-tenth of its area, without spending one drop of Russian blood.

Anderson called on every American to meet the threat of extreme inflation by working longer hours to produce more and to keep money out of circulation by savings, so that the inflationary effect of government military spending be held to a minimum.

Dangerous budget. — This huge military budget is dangerous, he said, because it comes at a time when unemployment is low, and at a time when more people are making more money than ever before. In order for the people of this country to maintain themselves in the state of emergency that will be necessary for a long period of time it will be necessary to increase taxation, and it is also necessary for workers to furnish more production at longer hours, and with fewer work stoppages. There is too much buying power for the goods available, a causative of inflation.

Officers.—Officers who head the association during 1951-52 are: M. E. McCullough, president; Eugene B. Clark, first vice president; Charles N. Prothro, second vice president; and Fred Sehmann, executive vice president.

Deep Wildcat in Trouble

HOUSTON.—Difficulty was still being experienced with the deep wildcat test in Stone County, Mississippi, March 27, which blew out March 2 after reaching a depth of 20,300 ft.

The test, George Vasen 1 Tung Oil Corp., will be the world's deepest producer if completed. Tom McKinney, drilling superintendent for Vasen, told The Oil and Gas Journal that the core bit is on bottom, but high-pressure gas is making it difficult to keep the mud properly conditioned. He is attempting to hold the mud weight at around 10.4 lb. per gallon.

Since getting the well under control and putting the bit back in the hole, the operators have drilled only 2½ ft. They are attempting to drill through the producing formation.

There has been much speculation on the geologic age of the pay, but no word from Vasen. He is reported to have already purchased the necessary casing for completing the well.

Louisiana Cuts Allowable

BATON ROUGE. — The Louisiana Conservation Commission has ordered the state's April crude-oil-production allowable set at 636,240 bbl. daily, 1,273 bbl. daily under the 637,513 bbl. March allowable.

GULF COAST

Tidelands Measure

Senate interior affairs committee now studying views on quitclaim legislation; Californian introduces new bill

Bertram F. Linz

WASHINGTON. — The Senate interior affairs committee received the views of the Departments of Justice and Interior on tidelands-quitclaim legislation this week, preparatory to taking a vote which, it is forecast, will kill the O'Mahoney bill for interim federal management and send the quitclaim measure to the Senate floor for action.

It became evident at the hearings last month *(The Oil and Gas Journal, March 1, 1951, page 22)*, that O'Mahoney could not get his interim legislation out of the committee, of which he is chairman, and he indicated at that time he was ready to throw his hand in and let the Senate consider a quitclaim.

At this week's hearing, Solicitor General Philip B. Perlman and Mastin G. White, solicitor of the Interior Department, opposed any alienation of the rights given the Government by the Supreme Court in the offshore oil resources of California, Texas, and Louisiana, but their views were not expected to have any influence on committee members determined to force a showdown on the issue.

Delegates slow down.—Meanwhile, in the House, the delegations from the coastal oil-producing states slowed down their consideration of strategy to bring quitclaim legislation up for consideration pending the anticipated Senate action. Given little encouragement by Speaker Sam Rayburn of Texas, who had fought vigorously for quitclaim legislation but had come to the belief that a modified bill for interim federal management was the only way to break the long stalemate, the oil-state members had been trying to decide whether to wait until the Senate acted on the O'Mahoney bill and if it passed, substitute the quitclaim measure when the legislation reached the House or to try to get direct action on the latter.

Proponents of quitclaim legislation claim it can be passed by both House and Senate over a presidential veto, although admitting it would be more pleasant if President Truman were convinced he cannot secure federal management and approved the measure. However, the President's well-known persistent adherence to views on which he has made up his mind makes such a possibility remote.

Super-quitclaim.—As the Senate committee prepared finally to act on tidelands, Rep. Carl Hinshaw of California was attempting to round up support for a super-quitclaim measure which he dropped in the House hopper last week.

Hinshaw's resolution differs from the many similar measures previously introduced by setting up legal definitions of terms that have come into common use as a result of the litigation over the tidelands and calling for negotiation with Mexico over the boundary between that country and the United States in the Gulf of Mexico.

The terms "tideland," "submerged land," "high seas," "inland waters," "coast," and "coast line" and others have been subject to serious misunderstandings, Hinshaw declared, and should now be defined so that no future misinterpretation of their meaning is possible.

Define "tideland."—His resolution defines "tideland" as the territory between the contour line at the elevation of mean high tide and the contour line at the elevation of mean low tide, lying along a tidal water margin or shore. "Submerged land" is defined as the continuation beneath the territorial waters of land territory having an elevation lower than the elevation of mean low tide or mean low water.

The measure also provides that the boundaries of the United States "are coextensive with the international and maritime boundaries of the border and maritime states" and the state boundaries, in turn, "extend to and coincide with boundaries of the United States."

Other provisions.—It further provides that the United States disclaims in perpetuity any right, title, or interest in or to any submerged lands, filled lands, made lands, or anything of value that may have been or may be erected within, on, or above them, except such rights as are specifically granted by the constitution or legally acquired for compensation, and, "if any such right, title, or interest may have been acquired by the United States by virtue of any decision or decree of the Supreme Court of the United States, then the United States does hereby quitclaim such right, title, or interest unto the states, their lessees, licensees, grantees, and all persons having lawful interest of any kind pursuant to the laws of a state forever."

Poor Investment

Federal freeze on Gulf tidelands activity means it will take 22 years to pay out investment in oil development

Leigh S. McCaslin, Jr.

HOUSTON.—The current congressional controversy over administration of the Gulf of Mexico tidelands is a wrangle over a poor investment, to judge by the experience of oil companies operating there.

To date the oil industry has got back only $1 for every $18 invested in offshore exploration and development work, and the outlook for the future is little better now that the federal Government has stopped further drilling. If the current freeze continues indefinitely, it will take 22 years for the present rate of production to pay off the investment.

Field reports reveal that there are only seven active drilling wells in the vast Continental Shelf area of the Gulf of Mexico. (See Table 1.) At the peak of activity there were 26 rigs running in the Gulf.

New wells banned.—The secretary of the interior has called a halt to any new drilling. Only those wells which were being drilled on December 11, 1950, can be completed. No new wells, either development or exploratory, can be commenced. Geophysical exploration has practically stopped also. Offshore lessees reported to Congress last month that only five geophysical crews are operating in the Gulf of Mexico. This compares with 48 crews which were operating at the peak of activity.

Cumulative production from Louisiana offshore oil wells is now past the 5,000,000-bbl. mark. There is no oil production off Texas. The current production rate from offshore wells is about 15,000 bbl. daily.

Report issued.—This and other data on Gulf of Mexico oil is contained in a special report just prepared by James H. Tillery, Jr., petroleum engineer for the Louisiana Conservation Department. Since November 1947, the report shows, the drilling of 176 wells in the waters off Louisiana has resulted in the discovery of 26 oil or gas fields. Thirteen of the offshore fields were discovered in 1949, but only three were found last year when exploration practically ceased following the controversy between federal and state governments over ownership.

The estimate, $1 returned for $18 spent, is based on Tillery's report and a statement before Congress recently by Walter S. Hallanan, president of Plymouth Oil Co. Hallanan says the industry has an investment to date in the tidelands of $250,000,000. At a premium price for oil of $2.80 per barrel, the 5,000,000 bbl. produced has a value of $14,000,000. Thus, simple arithmetic gives the low return of $1 for each $18 invested.

TABLE 1—ACTIVE WELLS IN THE GULF OF MEXICO

Operator, well number, parish, and field—	Ft.
Humble, F-2 St. Lse. 799, Jefferson, Grand Isle Blk. 16 (drlg.)	11,769
Shell, 1 St. Lse. 1388, Plaquemines, So. Pass Blk. 24 (drlg.)	2,290
Pure, A-3 St. Lse. 833, St. Mary, Eugene Isle Blk. 32 (tstg.)	9,854-56
Magnolia, A-4 St. Lse. 694, St. Mary, Eugene Isle Blk. 126 (testing)	11,611
Magnolia, C-2 St. Lse. 691, St. Mary, Eugene Isle Blk. 126 (drlg.)	11,200
Magnolia, D-3 St. Lse. 692, St. Mary, Eugene Isle Blk. 126 (drlg.)	4,324
Magnolia, A-1 St. Lse. 794, *Terrebonne, So. Pelto Blk. 20 (drlg.)	6,253

*Wildcat well—remainder are field wells.

Payout period.—Using these same basic figures, a payout period of 22 years can be derived for the investment not yet recovered. This payout figure assumes a producing cost of 85 cents per barrel (much higher than on land) and continued production at the rate of 15,000 bbl. daily.

TABLE 2

Field—	Wells—Oil	Wells—Gas	Present prod., bbl. daily	Total prod., bbl.
Bay Marchand	24	1	6,520	1,700,549
Breton Blk. 32	2	0	90	58,470
Eugene Island Breton Blk. 36	0	1	.....	.....
Eugene Island Blk. 32	2	0	270	44,365
Eugene Island Blk. 45	0	1	.....	.....
Eugene Island Blk. 51	0	1	.....	.....
Eugene Island Blk. 58	0	1	.....	.....
Eugene Island Blk. 110	0	2	.....	.....
Eugene Island Blk. 126	1	1	215	32,921
Grand Isle Blk. 16	2	2	8	26,637
Grand Isle Blk. 18	4	0	958	353,504
Main Pass Blk. 69	13	0	4,569	1,189,351
Ship Shoal Blk. 28	0	1	.....	.....
Ship Shoal Blk. 32	4	1	20	291,005
Ship Shoal Blk. 72	0	2	.....	.....
South Pass Blk. 24	3	0	1,034	82,729
South Timbalier Blk. 34	1	0	187	98,854
South Timbalier Blk. 52	1	0	101	3,138
Vermilion Blk. 39	0	1	.....	.....
Vermilion Blk. 72	0	1	.....	.....
Vermilion Blk. 76	0	1	.....	.....
W. Cameron Blk. 33	1	1	71	42,118
W. Cameron Blk. 45	2	1	436	52,538
W. Cameron Blk. 149	0	3	.....	.....
West Delta Blk. 27	0	1	.....	.....
West Delta Blk. 30	0	1	.....	.....
Total	60	24	14,492	3,976,179

According to Tillery's report, there are 10 companies operating in 1 or more producing fields at the present time. These companies have operations as follows:

Operator—	fields
The California Co.	2
Sunray Oil Corp.	2
Pure Oil Co.	2
Magnolia Petroleum Co.	6
Humble Oil & Refining Co.	6
Shell Oil Co.	1
Kerr-McGee Oil Industries, Inc.	2
Superior Oil Co.	3
Phillips Petroleum Co.	1
Stanolind Oil & Gas Co.	1

Although The California Co. has production in only two fields it is the largest producer in the Gulf of Mexico at present. The two fields in which it is interested—Bay Marchand and Main Pass Block 69—are the most highly developed of the 26 producing areas off Louisiana. Statistics concerning the 26 producing areas, as of November 1950, are given in Table 2.

MEETINGS

A. P. I. Group to Meet

COLUMBUS.—Various papers of interest to the producing division of the petroleum industry will be presented at the spring meeting of the eastern district of American Petroleum Institute's division of production here April 3-5. Headquarters will be in the Deshler-Wallick Hotel. J. French Robinson, president of East Ohio Gas Co., Cleveland, will preside at the opening session April 4.

Among papers to be delivered before the group will be:

"Confusing an Industry Problem," Russell B. Brown, general counsel, Independent Petroleum Association of America, Washington, D. C.; "Your Part in the Oil-Industry Public-Relations Program," C. Z. Hardwick, vice president, Ohio Oil Co., Findlay; "Field Results of Increased Flooding Pressures," Dr. E. T. Heck, chief geologist, and J. C. Vaughn, Quaker State Oil Refining Corp., Bradford, Pa.; "Selection of Pressure for Water-Flooding Various Reservoirs," John F. Buckwalter, Ryder Scott Co., Bradford, Pa.; "Recent Developments in Exploration in Northern and Central Pennsylvania," Dr. S. H. Cathcart, director of the Bureau of Topographic and Geologic Survey, Commonwealth of Pennsylvania, Harrisburg.

"Water Flooding of Limestones in Illinois and Kentucky," Kenneth P. Huffman, consulting engineer, Owensboro, Ky.; "Studies and Experiments With Paraffin Preventives and Removal From Wells in Southeastern Ohio," John C. Wright, Wiser Oil Co., Sistersville, W. Va.

F. W. Ellenberger, Kendall Refining Co., Bradford, Pa., will preside over the April 4 afternoon session, and K. C. Cottingham, Ohio Fuel Gas Co., Columbus, will preside at the April 5 morning session.

Combustion Conference

KNOXVILLE.—The second annual Combustion Conference will be held on the Knoxville campus of University of Tennessee April 5-6, under sponsorship of the university's mechanical-engineering department.

A similar meeting last year was attended by 365 participants, during which advantages and disadvantages of each of the four major fuels, coal, oil, gas, and electricity, were presented.

New Conservation Law

Colorado legislature adopts oil and gas-conservation act, replaces 3-member commission by new 5-member body

DENVER.—Colorado's old 3-member gas-conservation commission was succeeded by a new 5-member oil and gas-conservation commission last week when Gov. Dan Thornton signed into law the Colorado Oil and Gas Conservation Act of 1951.

The new law, designated as House Bill No. 347, was passed previously by the state House of Representatives on March 2 and by the Senate on March 14.

Four of the commission members will be appointed by the governor, and the fifth will be the state oil and gas inspector. All members must have had at least 5 years' experience in the practical production of oil and gas. They serve without compensation, with the exception of the oil inspector, who receives no additional compensation under the act.

Provisions.—The new law provides for payment of 1 mill per barrel of oil produced and marketed. The state treasurer credits the money to a special oil and gas-conservation fund. Funds are to be used exclusively for payment of operating costs of the commission.

The commission is given power under the law to fix drilling units, after a hearing with the parties involved. In the absence of voluntary pooling, the commission may enter an order pooling all interests in the drilling unit for the operation thereof upon receipt of applications from interested persons and following a hearing.

The law also defines oil, gas, pool, common source of supply, and "waste" pertaining to both oil and gas.

Responsibility and authority for enforcing the act is given to the commission. It may sue or be sued in its administration of the act, but cannot make a rule or issue an order without a hearing upon that rule or order. Notice of hearing must be given at least 10 days prior to the hearing.

Other powers.—The commission is also given authority to require:

1. Identification of ownership and location of oil or gas wells and producing leases;

2. The making and filing with the commission of well logs, provided that logs of wildcat wells marked "confidential" must be kept confidential for a period of 6 months after filing;

3. The drilling, casing, and plugging of wells in such a manner as to prevent escape of oil or gas from one stratum to another, intrusion of water into oil or gas stratum, or the pollution of fresh-water supplies by oil, gas, or salt water, and to prevent blowouts, explosions, and fires as a protection to the landowner's domestic and irrigation water supplies;

4. The furnishing of reasonable security conditioned upon the performance of the duty to plug each dry or abandoned well;

5. The keeping of accurate record for 5 years of quantities of oil and gas produced by every person producing oil or gas in the state;

6. Filing of a notice of intention to drill an oil or gas well; and

7. Safety measures to prevent fires and blowouts.

Section 14 of the law expressly prohibits the commission from issuing any orders requiring the restriction of production of any pool or any well to an amount less than the pool can produce without waste in accordance with sound engineering practices.

Repressuring.—The act allows agreements for repressuring or pressure-maintenance operations, and the carrying on of any other methods of unit or cooperative development or operation of a field or pool or a part of either. Statutes relating to trusts, monopolies, or contracts are not violated as long as the agreement is approved by the commission as being in the public interest or reasonably necessary for ultimate recovery and to prevent waste.

The law encompasses all lands in Colorado and federal lands within the state if the officer of the United States having jurisdiction over them approves the order of the commission affecting such lands. However, any lands committed to any unit or cooperative agreement approved by the secretary of the interior do not come under the act.

Notices of hearings.—Notices of hearings required under the act can be given either by personal service or by one publication in a newspaper of general circulation in the county where the land affected is located. All rules, regulations, and orders issued by the commission must be in writing and kept in indexed books by the commission which are open for public inspection.

The regulatory body is empowered to summon witnesses, to administer oaths, and to require the production of records, books, and documents for examination at any hearing or investigation conducted by it.

Wyoming action.—Other legislative activity in the Rocky Mountain area recently found Gov. Frank A. Barrett,

CONSERVATION ACT SIGNED.—Gov. Dan Thornton, of Colorado, hands the pen with which he just signed the new Colorado Oil and Gas Conservation Act to Hon. Warwick M. Downing, chairman, Colorado Gas Conservation Commission. Observing presentation, left to right: Charles S. Hill, president, Rocky Mountain Oil and Gas Association; H. C. Bretschneider, commissioner; Rep. John Vanderhoff, of Glenwood Springs, who introduced the bill; John Cronin, state oil and gas inspector; Max Bell, commissioner; and Gilbert J. Mueller and H. Leslie Parker, chairmen of the legislative committees, R.M.O.G.A.

of Wyoming, signing into law a bill to establish a state oil and gas-conservation commission. The law, which spells out the commission's authority to regulate oil and gas production, becomes effective July 1.

Shale-Oil Estimates Upped

The U. S. Bureau of Mines estimates of the oil recoverable from the Green River oil-shale formation in northwestern Colorado have been increased by two-thirds as a result of recent additional exploratory tests.

Estimated some 3 years ago to give a theoretical yield of 300,000,000,000 bbl. of oil from shale running 15 gal. a ton or more, the 1,000-sq. mile area in the Piceance Creek Basin, which is considered of possible economic importance, is now believed to be capable of providing 494,000,000,000 bbl.

The bureau estimates that the richest area, of shale running 25 gal. or more to the ton, has a theoretical yield of 125,000,000,000 bbl. of oil as against the 90,000,000,000 bbl. originally envisaged. This area is considered as economically important now, but technological advances are expected to make lower-grade shale economically usable at some future time.

The bureau's estimates are of theoretical yield, and the actual recovery would depend on mining and processing losses. They are based on assay reports, it was pointed out, and are still far from final. The figures were compiled on the basis of assays of 26 cores from diamond-drill holes, 4 rotary cuttings from oil wells, and 15 channel samples from cliff outcrops.

CANADA

Gas Export O.K.'d

Alberta to let Montana copper company use fuel

ALBERTA will authorize a 5-year export of natural gas to Montana immediately, but purely for defense purposes to serve the needs of the vital Anaconda Copper Mining Co. operation in Montana, Premier E. C. Manning announced to the legislature in Edmonton last week, when he introduced a special bill. The government was requested to allow export by C. E. Wilson, United States presidential appointee to the directorship of the United States defense mobilization.

The Alberta gas will be supplied from the Pakowki Lake area, just north of the Alberta-Montana border in Southeast Alberta. A pipe line will be built from there to join Cut Bank, Mont., gas field which now supplies the copper company. The maximum volume to be exported will be 10,000,000,000 cu. ft. a year, or 40,000,000 cu. ft. per day, to be supplied from holdings of the McColl-Frontenac Oil Co. and Union Oil Co. of California.

Four fields.—At Pakowski Lake there are four separate gas fields involved for the gas export. They are in an area 35 miles square, immediately north of the Montana border and some 40 miles south of Medicine Hat. The fields are 170 miles southeast of Calgary at their nearest point. The four fields have estimated "net marketable gas reserves" of 406 billion cubic feet.

The fields were explored for and discovered by McColl-Frontenac and Union, with initial discovery coming in 1943. The others were found in 1946 and 1947. The original objective was crude oil, but no oil in commercial volume resulted, though a total of 49 wells were drilled between 1943 and 1950.

Pipe-Line Route Approved

OTTAWA.—Route of an all-Canadian crude-oil pipe line from Edmonton to Vancouver has been approved by the Canadian House of Commons.

A bill incorporating Trans-Mountain Oil Pipe Line Co., which plans an all-Canadian route, was passed by the group after approval by the senate *(The Oil and Gas Journal, March 22, 1951, page 71)*.

A filibuster was in progress, however, against a bill to incorporate Border Pipe Line Co., which plans a line incorporating a part-American route to Vancouver.

Trans-Canada Pipe Lines, Ltd., has already been incorporated by parliament to pipe natural gas from Alberta eastward 3,100 miles to Montreal, but Alberta has banned gas exports until it obtains information on existing reserves.

Alberta Leases Acquired

EDMONTON.—Amerada Petroleum Corp. and Basin Petroleums, Ltd., have acquired oil and gas reservations from the Alberta government on 838,548 acres of land.

Amerada acquired rights on 798,720 acres in northwestern Alberta taken out in eight reservations, each of approximately 99,840 acres. The block is located in the Buffalo Head Hills-Buffalo River area and runs about 85 miles long in a north-south direction, and is about 18 to 20 miles wide.

The reservations were taken out in Amerada's name, and in the names of four of its subsidiaries: Alberta Canarada Petroleum Corp., Alberta Monterada Petroleum Corp., Alberta Calgarada Petroleum Corp., and Alberta Bretorada Petroleum Corp.

Line Provision Sought

TORONTO.—To facilitate the possible importation into Ontario of gas from the United States, Hon. W. S. Gemmell, minister of mines, has introduced in the provincial legislature a bill to permit the laying of large-diameter, high-pressure pipe lines across private property, with provision for arbitration to fix the compensation to the property owner.

TEL to Be Allocated

OTTAWA.—In view of the current shortage of tetraethyl lead, it is proposed to direct the two Canadian suppliers, Ethyl Corp. and Canadian Industries, Ltd., to allocate supplies to their customers beginning on April 1, Dr. O. B. Hopkins, director of the petroleum division of the Department of Trade and Commerce, advised all Canadian refiners last week.

In the 12-month period beginning April 1, no refiner shall be supplied with more TEL than his base allotment plus 80 per cent of the quantity obtained by subtracting the refiner's base allotment from amount of TEL used by him in the base period, Hopkins said. The base period is defined as the calendar year 1950.

The base allotment for any refiner will be either 1,000,000 lb. of TEL or the number of pounds of TEL used by such refiner in the base period, whichever is less. The refiner will not be supplied more than 35 per cent of his total allotment in any quarter beginning with April 1, Hopkins reported.

In hardship cases, requests for additional allotments over that set will be considered by the Petroleum Division, Hopkins said.

Quiz Vote

ON page 283 of this issue is something new—a quiz on refining. It is a kind of game, but it is a lot more than that. It is a brief refresher course, and its real purpose is to help readers check the breadth of their knowledge on this branch of the industry.

Similar refresher quizzes could be prepared for other branches of the industry. They will be if refiners like this one and if readers in other branches request similar quizzes on such subjects as drilling, natural gasoline, pipe lines, or other phases of the business. All readers are requested to vote their desires on the reply postal card which faces page 283.

LATIN AMERICA

Venezuelan Limit

Approaching exhaustion of 1951 quota for 10½-cent oil imports into U. S. to result in revenue loss, lower netback

Dahl M. Duff

A LOWER netback to Venezuelan producers and a consequent loss of revenue to the Venezuelan Government now appear likely as a result of the approaching exhaustion of the 1951 quota for 10½-cent oil imports into the United States from that country.

Venezuela is allowed 59.4 per cent of the 104,743,350 bbl. of crude, fuel oil, and gas oil which can be imported this year at 10½ cents under the revised tariff arrangement. Assuming the rate of imports does not change materially, Venezuela will fill its quota by the latter part of June. When that happens, the import tax jumps to double the lower rate, or to 21 cents a barrel.

Because of the heavy winter demand for fuel oil, the Netherlands West Indies quota of 18.7 per cent of the 10½-cent imports was closed by the Customs Bureau on March 4. Though the quota was believed not actually completely filled, the amount already brought in apparently was near enough the limit to cause the bureau to begin levying the higher duty with the possibility of some refunds later.

Policy to continue.—Information in the industry indicates that the Venezuelan producing companies will continue their accepted policy of absorbing the amount of the duty on United States imports after the higher tax takes effect. This step is dictated by the necessity of keeping the price to the buyer in the United States at a level competitive with crude from the United States Gulf Coast. Present contracts in general provide for cancellation if neither the buyer nor the seller agree to absorb increased import taxes.

Unjustified.—Venezuelan Government officials are understood to feel that the increase in the United States duty is quite unjustified particularly since it comes at a time when more and more emphasis is being placed on Western Hemisphere oil and its importance to national defense. In fact, some informed sources in this country would not be surprised if Venezuela canceled its own trade agreement and placed all oil imports into the United States on a 21-cent basis.

Venezuela's income taxes, which depend on earnings of the producing companies, will be adversely affected, and there is a possibility that the royalty oil price will be lowered. At present, the price which Venezuela receives for royalty oil bought by the producing companies includes a pro rata deduction of the United States duty. If a further allowance is made for the additional duty going in effect later this year, Venezuela will in effect be paying the higher tax to the extent of its one-sixth royalty.

Lower return.—With the producers absorbing the higher duty, the effect will be a lower return on sales at a time when these companies already are facing higher costs at the other end of their operations—in the current demands of the Venezuelan oil labor unions for pay increases and more social benefits. A 10 to 12 per cent increase in labor costs has been predicted as the outcome of the still unsettled labor demands.

The technique of absorption of the additional duty when the quota runs out raises other problems for the Venezuelan companies. These companies have long adhered to a "one-price-to-all" policy under which the crude price is based on the United States gulf price and adjusted for different freight rates and the United States duty in order to allow the oil to be laid down on the East Coast on a par with shipments from the gulf. The same f.o.b. price is charged to European buyers.

Exports to Europe.—The absorption of the additional tax presumably will be accomplished by a credit to the United States buyer, if the existing basic price in Venezuela is not to be changed. Though Venezuelan crude shipments to Europe are being gradually supplanted by supplies from the Middle East, the movement is still fairly substantial, and a credit off the prevailing Venezuelan price to the United States buyer immediately brings up the question of the position of the European buyer and the Economic Cooperation Administration which has insisted that the shipments it finances be at the lowest prevailing price. However, the basic fact is that the delivered price to both United States and non-United States buyers would be the same.

This somewhat confused situation in regard to United States oil imports

Newest Venezuelan Refinery Installation

Venezuela now ranks as a major refining center as well as the world's second largest producing country. Construction last year almost tripled Venezuelan capacity, bringing it to approximately 300,000 bbl. daily. Shown here is a partial view of one of the newest and largest Venezuelan refining installations, that of Creole Petroleum Corp. at Amuay Bay on Paraguana Peninsula. In left background is Punta Adaro staff family and bachelor housing. In right background are piers and bunker-fuel tanks on Punta Judibana. In the foreground is the town of Las Piedras.

has arisen out of last year's termination of the trade agreement between the United States and Mexico. This action in effect returned oil-import taxes to the system prevailing under the older 1939 Venezuelan trade agreement. The 10½-cent tax was allowed on an annual quantity of crude, gas oil, distillate, and residual equal to 5 per cent of the previous year's domestic refinery runs. Washington officials subsequently allotted the Venezuelan and Netherlands West Indies quotas for the bulk of the lower-tax oil, and put all other countries on a "first-come, first-served" basis.

Higher tax expected.—The higher tax for countries other than Venezuela and the Netherlands West Indies is expected to go into effect about April 20. Venezuela's share of the low-duty oil amounts to 62,000,000 bbl., of which only about 24,000,000 bbl. had been taken as of March 10. The Netherlands West Indies' quota totaled about 19,000,000 bbl., with 17,000,000 used as of March 4. Shipments from the Netherlands West Indies are largely fuel oil coming out of the Aruba and Curacao refineries which operate on Venezuelan crude.

The pricing system for imported fuel oil is not expected to be altered as a result of the higher tax. Most imported fuel oil enters the East Coast where it is sold in competition with coal, and absorption of the higher duty by the fuel-oil buyer appears even more out of the question than in the case of crude oil. While the European buyer of Venezuelan crude gets the benefit of the present 10½-cent duty allowance, this is not the case with fuel oil, and the Caribbean refiners in general make allowances for the United States tax only for United States destinations.

Texaco view.—The views of some, if not all, the larger importing oil companies on the present oil-import duty were expressed last week by The Texas Co. in a stockholder's letter accompanying its annual report. The company said: "The great strategic importance of these foreign-oil reserves has now become apparent to everyone, and the soundness of the long-range view that we should encourage American production of foreign oil by permitting reasonable imports has been demonstrated. In accordance with this view, it is desirable that appropriate action be taken to lower the import duties recently imposed on petroleum and its products at least to the level of those in effect before the recent cancellation of the Mexican trade treaty."

MIDDLE EAST

Iranian Action

Nationalization proposal awaits Shah's approval

THE oil-nationalization proposal in Iran was unanimously passed by the upper house of the Iranian parliament last week, while in adjoining Iraq, a minority bloc in the parliament formally demanded the government take similar action against Iraq Petroleum Co., Ltd.

The Iranian Government extended martial law to several more areas after a general strike was called against Anglo-Iranian Oil Co., Ltd. The strike was reported to have been incited by the outlawed Communist Tudeh party. Company workers, joined by students and apprentices, demanded higher pay, but as far as was known, Anglo-Iranians operations were continuing.

In Baghdad a group of 18 members of the Iraq Parliament introduced a resolution in the Chamber of Deputies requesting the government to draft legislation for nationalization of oil. The industry in Iraq is operated by Iraq Petroleum Co., Ltd., and two associated companies. About 150,000 bbl. daily is produced from Kirkuk field.

There are 140 members of the Iraq Parliament, and the resolution was expected to be opposed by the government party of Premier Nurigess-Said which is against public ownership of oil. The development in Iraq, though thus far not as serious as the situation in Iran, was of interest particularly since it was a direct result of the nationalization vote in Iran.

In Iran, the disturbances which preceded the vote on the nationalization law by the Majlis, or lower house, quieted after the government declared martial law in Teheran.

Next step.—Next step on the part of the Iranian Government presumably will be to proceed with the 2-months' study of ways to carry out the proposal to take over the properties of Anglo-Iranian Oil Co., Ltd. Renewed efforts probably will be made during this period to effect some sort of settlement short of nationalization itself. Whether this will be possible in view of the law and the feeling in the country, remains to be seen.

Earlier reports from Teheran said the nationalization proposal called for the employment of foreign experts to assist with the study. An approach in this country for this assistance has been anticipated, and there were unconfirmed reports in New York last week that certain Americans had made offers to Iran. However, it was considered almost certain that none of the large oil companies in the United States which have sufficient resources and experience would enter into any such arrangements.

The British are certain to resist by all possible means the nationalization of the company which has been termed Britain's most important single foreign investment. The case will be taken to the International Court at The Hague on the legal ground that the concession agreement is valid until 1993.

Other developments. — There were these other developments last week:

The Saudi Arabian foreign minister, Prince Feisal, who is King Iban Saud's son, said that the nationalization of the Iranian industry would not affect Saudi Arabia in the least. The operating company is Arabian American Oil Co. which several months ago signed a 50-50 participation agreement with the government.

The Iraqi economics minister was in London preparing to institute a suit against Iraq Petroleum Co., Ltd., over the issue of paying royalties on the basis of the free and not the official gold rate. The action of the Iranian Parliament attracted considerable attention in this country and in Egypt.

Possible agreement. — Earlier reports from Teheran indicated the government there, or at least some segments of it, may be thinking in terms of an agreement under which Anglo-Iranian would continue to operate its properties as an agent of the Iranian Government. Only if an arrangement along this line could not be worked out would the Iranian Government actually undertake operation of the concession.

In the Iranian Parliament, fanatical nationalists last week demanded that the government seize Bahrein Island, an independent Arab state in the Persian Gulf where Bahrein Petroleum Co., Ltd., carries on producing and refining operations. Iran has been claiming the island for the last 30 years, and the demand reflected the frenzy of nationalistic sentiment in the Iranian capital.

AFRICA

Kenya Held Promising

The commercial-intelligence division of the Department of Commerce has published a report that preliminary surveys in Northeast Kenya indicate possible petroleum deposits in that area.

The report, originally published locally, identified the potential oil area as about 14,000 sq. miles in the northern frontier district and a coastal strip extending from the Tanganyika boundary to the Somaliland boundary.

American firms interested in this possibility should correspond with the Commissioner for Mines, Kenya Mines Department, Nairobi, Kenya, British East Africa.

PERSONALS

Veteran Refiner

Scott heads Sinclair's new petrochem division

JOHN A. SCOTT, recently appointed to head Sinclair Refining Co.'s newly organized petroleum-chemicals division, has been with the company since 1934.

A graduate of University of Minnesota, where he received a degree in chemical engineering, Scott, upon joining Sinclair, was assigned to the research and development department East Chicago, Ind.

Transferred in 1944 to the company's Corpus Christi refinery, he worked on the design, construction, and initial operation of the plant's alkylation unit. In 1945 he was transferred to New York City, where he became assistant to the vice president in charge of research and development. He held this position until his most recent appointment.

Scott is a member of the American Institute of Chemical Engineers, and is active in the Society of Automotive Engineers.

In his post as head of the petroleum-chemical division of Sinclair, he will supervise all expansion of petrochemical manufacture by the company.

Charles R. Olson, assistant petroleum engineer for Ohio Oil Co. at Henderson, Tex., has been transferred to the Shreveport division office as reservoir engineer and general petroleum engineer.

E. E. Holden, general supervisor of pipe lines and engineering for Transcontinental Gas Pipe Line Corp. at Houston, has been transferred to Corpus Christi, Tex., as general supervisor of pipe-line operations and maintenance for Texas.

E. V. Hodge, superintendent for Warren Petroleum Corp. at Salem, Ill., has been transferred to Ringwood, Okla., as superintendent of the new natural-gasoline plant erected there.

Joseph Roy Christian, exploitation engineer for Shell Oil Co., has been transferred from Houston to Hobbs, N. M., as field engineer.

Jack H. McCollum, geologist for Kingwood Oil Co., has been transferred from Oklahoma City to Scotts Bluff, Neb., in the same capacity.

Robert E. Caraway, district engineer of the North Texas district for Standard Oil Co. of Texas, has been transferred to Gainesville, Tex., as production foreman.

Milton H. Kuhleman, formerly subsurface geologist for The California Co. at Jackson, Miss., has joined Ashland Oil & Refining Co. at Henderson, Ky., as subsurface geologist.

William P. Gee, vice president of Texaco Development Corp., has been promoted assistant to the president of The Texas Co. Gee joined the firm in 1927 as a research chemist in the Port Arthur, Tex., refinery.

W. J. Arnold, seismograph party chief for Amerada Petroleum Corp., has been transferred from Childress to Floydada, Tex., in the same capacity.

J. W. Gillespie, field superintendent for Ohio Oil Co. at Henderson, Tex., has been transferred to Haynesville, La., as district superintendent.

J. D. Maxey, district superintendent of Oklahoma for Sinclair Pipe Line Co. with headquarters at Shawnee, Okla., has been transferred to Independence, Kans., to supervise operation of the southwestern division of products pipe lines.

Malcolm M. Mulholland, district geologist for Carter Oil Co., has been transferred from Mattoon, Ill., to Grand Rapids, Mich.

V. M. Pritchard, tool pusher for Penrod Drilling Co., has been transferred from Sonora to El Dorado, Tex., in the same capacity.

E. Forbes Gordon, drilling-mud engineer for The Texas Co. at Houma, La., has been transferred to El Campo, Tex., as reservoir engineer.

Edmond O. Markham, geologist with Carter Oil Co. for the past 30 years, has resigned to become a consulting geologist at Tulsa. He joined the firm in 1920, and was transferred to Denver as district geologist in 1924. In 1926 he was assigned to a geological study of the Olympic peninsula area of northwestern Washington, and on his return to Tulsa was placed in charge of subsurface work. He was later named assistant to the chief geologist, and at the time of his resignation was staff geologist representing the central division.

A. W. Bredlow has been named superintendent of Standard Oil Co.'s marine and filling racks division at Whiting, Ind. Other appointments in the same department include: **D. V. Hartzell,** named assistant superintendent; **George Fraser,** named general foreman; and **Joseph Windhauser,** appointed assistant general foreman.

L. H. ALBUS

L. H. Albus, manager of the Jayhawk Works for Spencer Chemical Co., has become an assistant to the vice president in charge of operations as general works manager. He will be responsible for production activities at all of the company's five plants. Albus joined the firm in 1942 as superintendent of gas reforming at Jayhawk, was promoted to production superintendent in 1943, and named works manager in 1946. Other new assignments include: **R. F. Brown,** assistant to the vice president and chief engineer, becomes an assistant to the vice president in charge of operations as manager of industrial services; **V. F. Hobart,** works manager at Henderson, will return to Jayhawk as works manager succeeding Albus; **J. C. Denton,** production superintendent at Jayhawk, replaces Hobart at the Henderson plant as works manager; **George F. Klein,** director of process development in the research and development department, will suceed Brown as chief engineer; **W. R. McCluskey,** superintendent of the Jayhawk ammonia section, will take over Denton's responsibilities as production superintendent at Jayhawk; **F. A. McGuire,** superintendent of the Jayhawk gas-reforming section, has been named superintendent of the ammonia section; **C. C. Bradney,** personnel manager of Jayhawk, named public relations representative; and **E. J. McMillan,** administrative assistant of the research and development department, named personnel manager succeeding Bradney.

PERSONALS

I. H. Hughes, assistant division manager of the La Brea-Parinas estate, Talara, Peru, of International Petroleum Co., Ltd., has been promoted to division manager, replacing **H. C. Carroll,** who has been transferred to the Lima office as a member of the firm's management committee. Hughes started his career in foreign operations with Phillips Oil Co. in Venezuela in 1945.

Dr. Herman Pines, a research coordinator with Universal Oil Products Co., Chicago, has been appointed associate professor of chemistry at Northwestern University.

A. H. Silberberg, formerly petroleum engineer for West Texas Engineering Service, Inc., at Midland, Tex., has joined D. D. Feldman Oil & Gas Co. at Royalty, Tex., as engineer on the water-flood project in South Ward field.

Pierre Lasnier, S. N. Repal, Sidi Aissa (Alger) Algeria; **Rene Sorel,** Societe Chorifiene des Petroles, Petitjean, French Morocco; **Jacques Puech,** Societe Nationale de Recherche des Petroles en Algerie; and **Jean Seguret,** Societe de Recherche et d'Exploitation des Petroles en Tunisie (SEREPT), are at present in the United States on a tour of observation and study of the oil industry. Puech and Seguret will remain in the United States a month under auspices of Gulf Oil Corp.

Peter F. Chapman, field engineer for Shell Oil Co. at Centralia, Ill., has been transferred to Elk City, Okla.

Cecil E. Brandon, junior petroleum engineer for British-American Oil Producing Co. at Oklahoma City, has been transferred to production-research department at Tulsa.

G. E. Hatton, geologist for Phillips Petroleum Co. at Amarillo, has been transferred to Bartlesville, Okla., as assistant to the division geologist.

H. M. Kirkpatrick, Shell Oil Co., has been transferred from Tulsa to the Kansas division as production geologist. Other changes in the firm include: **W. P. Sandlin,** exploitation engineer at Ardmore, Okla., transferred to the Oklahoma division as reservoir engineer; **J. M. Garlick,** division exploitation engineer in the North Texas division, promoted to division production superintendent; **E. N. Durham,** division reservoir engineer in the Oklahoma division, transferred to North Texas and promoted to division exploitation engineer; **J. F. Hunt,** division reservoir engineer at North Texas, transferred to the Oklahoma division; **J. M. McUsic,** geologist in exploration and production research at Houston, transferred to the exploration department in Tulsa; and **F. C. Buckwalter,** exploitation engineer at Oklahoma City, transferred to the Ardmore district.

PETROLEUM CLUB OFFICERS.—Newly elected officers of the Petroleum Club of Los Angeles. Left to right: James G. Leovy, Western Gulf Oil Co., secretary; Rollin Eckis, chief geologist for Richfield Oil Corp., president; and W. H. Geis, consulting petroleum engineer, vice president.

Murray J. Wells, regional geologist for the Oklahoma and North Texas districts for Cities Service Oil Co. at Bartlesville, Okla., has been named division geologist in the northern Rocky Mountain division with headquarters in Casper, Wyo. Wells will be succeeded by **Paul H. Hyatt,** formerly a member of the firm's geological staff at Oklahoma City. **T. C. Hiestand** will serve as regional-staff geologist at Casper. Wells, who has been with the firm since 1936, was named division geologist in 1943.

O. I. Torkelsen, manager of the western division covering exploration and land acquisition for British American Oil Co., Ltd., has been named to the newly created position of exploration and production coordinator with headquarters in Toronto. A graduate of University of California, Torkelsen joined the firm 12 years ago as field geologist. In 1946 he was made a vice president of the producing company in charge of all production activities in the western division, and in 1948 promoted to manager of the western division.

C. C. Wallace, district foreman for Sun Pipe Line Co. at Longview, Tex., has been transferred to Liberty, Tex., in the same capacity.

Ervin L. Laughlin, petroleum engineer for Standard Oil Co. of Texas at Snyder, Tex., has been transferred to Gainesville, Tex., as district engineer.

Ivan M. Rice, formerly assistant district engineer for Gulf Oil Corp.'s Kansas district, has organized Rice Engineering Co., Chase, Kans., specializing in organizing, designing, and operating salt-water-disposal systems.

Harold E. Jones, surface geologist for Stanolind Oil & Gas Co. at San Angelo, Tex., has been transferred to Midland, Tex., as subsurface geologist.

William G. Allen, party chief for Keystone Exploration Co., has been transferred from Sweetwater to Plainview, Tex.

J. O. Hendricks, tool pusher for Lowell & Gist, Inc., has been transferred from Craig, Colo., to Casper, Wyo.

R. C. Cashin, geological engineer for Phillips Petroleum Co., has been transferred from Cotulla to Midland, Tex.

R. J. Gutru, Kansas district geologist for Champlin Refining Co., has resigned and will join Beardmore Drilling Co., Inc., as geologist.

Lyle R. Duty has been appointed assistant to the executive vice president of Pan-Am Southern Corp., and **Carl W. Peters** has been named manager of economics. Duty was with Standard Oil Co. (Ind.) for 22 years before joining Pan-Am. His last assignment was special representative of the comptroller of the Indiana company. Peters was formerly in a su-

PERSONALS

pervisory and administrative position in the research department of Standard Oil Co. (Ind.) at Whiting, Ind.

Richard G. Crippen, petroleum engineer for The Texas Co. at Salem, Ill., has been transferred to Farina, Ill., in the same capacity.

Tom L. Ingram, geologist for Stanolind Oil & Gas Co. at Midland, Tex., has been named area geologist for the eastern Permian basin area. He succeeds **Charles R. Barr** who has been transferred to Wichita as district geologist.

Dr. Kenneth K. Kerby has been appointed a senior research associate of Standard Oil Development Co. in recognition of his research work on synthetic rubber and high-octane gasoline.

Edward W. Scott, district geologist for Union Oil Co. of California at Shreveport, has been named assistant division geologist for the Texas-Gulf district at Houston. **Hamlin G. Fox** succeeds Scott at Shreveport.

N. V. Kinsey and **Norman V. Kinsey, Jr.,** of Kinsey & Kinsey, independent operators, have moved their headquarters from Carthage, Tex., to Shreveport.

Sol Meltzer, scout for Cities Service Oil Co. at Amarillo, has been transferred to the West Texas-New Mexico district office in Midland, Tex., as development geologist.

Glenn W. Sandberg, geologist for Sunray Oil Corp., has been transferred from San Antonio to Denver in the same capacity.

R. L. May, asphalt-plant operator, has been named assistant process engineer at Sohio Petroleum Co.'s Latonia refinery, Covington, Ky.

Stanley B. White, district geologist for Ohio Oil Co. at Durango, Colo., has been transferred to Salt Lake City where he will open offices for the firm.

Bill Frazier has been transferred by Superior Oil Co. from California to Casper as a petroleum engineer in the company's Rocky Mountain division.

M. S. Keffer has been appointed crude-oil buyer in the West Central Texas district for Stanolind Oil Purchasing Co., with headquarters at Abilene, Tex.

Jud Noble, recent graduate of the University of Illinois, has joined the geological staff of Kingwood Oil Co. at Mount Vernon, Ill.

Arthur R. Erickson, formerly assistant division geologist at Bartlesville, Okla., for Phillips Petroleum Co., has joined Northern Natural Gas Co. of Omaha, Neb., as chief geologist to head the firm's exploratory effort in Kansas, Oklahoma, and Texas. He joined Phillips in 1941 after graduating from University of Oklahoma. Following 6 years of surface and subsurface study in the Panhandle area he was transferred to Bartlesville as assistant division geologist.

Paul J. Natho, district superintendent for Pan American Production Co. at Easton, La., has been transferred to Houston as mechanical engineer.

George D. Porter has been appointed manager of the valuation department of Equitable Gas Co. in Pittsburgh. Porter, a graduate of Carnegie Institute of Technology, joined Equitable Gas in 1929 as an apprentice engineer and has since served as junior engineer, subsection engineer, and section engineer.

DEATHS

Frank Carlton Kittle, 57, an engineer with Lummus Co. in New York, died March 17 in White Plains, N. Y.

George W. McKnight, 80, who retired in 1933 as a vice president of Standard Oil Co. (N. J.), died March 20 in Montclair, N. H. McKnight joined the old Standard Oil Co. in 1885 as an office boy in New York. He advanced through various executive positions before being named vice president.

P. J. Hoffmaster, 58, director and supervisor of wells for the Michigan Department of Conservation, died March 19 in Lansing, Mich.

John A. Walling, 74, oil man and contractor, died in Houston recently.

Lewis B. Sterling, 41, independent oil operator, died in Houston recently.

Edmund L. Buckley, an oil-development pioneer at Tampico, Mexico, died in Houston. He was founder and president of Midland Oil Co.

Frank A. Hill, 59, vice president and part owner of Southwest Oil Field Transportation Co., Houston, died of a heart attack March 18.

Daniel E. Horrigan, 57, formerly with The Texas Co. and Papoose Oil Co., died in Tulsa March 21. Until recently he had been associated with Larkin Torpedo Co.

Leslie E. Sebald, vice president of engineering for Griscom-Russell Co., died March 5.

GEOLOGICAL SOCIETY OFFICERS.—New officers of the West Texas Geological Society of Midland are, seated, left to right: W. Dave Henderson, consulting geologist and independent oil operator, president; Roy M. Huffington, Humble Oil & Refining Co., secretary. Standing: C. H. Atchison, Honolulu Oil Corp., treasurer; and Alan B. Leeper, Honolulu Oil Corp., vice president.

XUM

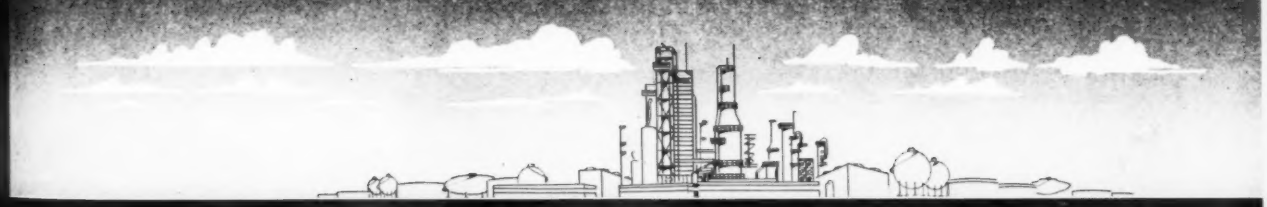
ANNUAL *Refining* SECTION

This 1951 Annual Refining Section is composed of three parts:

PROCESSING DETAILS.—Here you will find 39 easy-to-read flow charts and descriptions of the principal newer petroleum-refining processes. Discussions are sectionalized generally under (1) purpose, (2) major equipment used, (3) charging stocks, (4) products, and (5) operating essentials.

REFERENCE ARTICLES.—Engineering and operating articles contributed by authorities in the industry on a wide variety of subjects. These include a description of the use of scale models constructed of plastic materials to facilitate layout of additional piping and new equipment; how to check up on manpower requirements in a period of defense mobilization; the use of statistical analyses in operating and maintenance problems; selection and execution of research problems, and several others.

REFRESHER QUIZ.—Here is an entirely new feature which we feel you will enjoy. It affords you a pleasant opportunity to check up on your knowledge of refining. A list of 162 questions covers all phases of refinery operation. Three sets of answer sheets are included so that more than one reader can participate in the quiz. References are included so that you can bone up on those questions which might have been a little difficult.



THE OIL AND GAS JOURNAL

XUM

Fluid Catalytic Cracking

PURPOSE.—Convert heavier hydrocarbons to gasolines.

The U.O.P. fluid catalytic cracking process is adaptable to the needs of large and small refiners. Units designed in capacities ranging upward from 1,500 bbl. a day can be built and operated at costs comparing favorably with the cost of thermal cracking units of comparable capacity.

CHARGING STOCKS.—The process is flexible both as to charging stock and products. It can successfully crack kerosine, light or heavy gas oil, and some types of reduced crude.

RESULTS.—The process produces gasoline of a different character from that produced by thermal cracking. It can be operated to produce either aviation gasoline, high-grade motor gasoline, or raw materials for the production of chemicals and synthetic rubber.

The latest type unit can utilize either synthetic or natural catalyst. In its most simple design, synthetic catalyst which has a microspherical form is used. Because of the spherical shape of the particle and its greater strength as compared with the ground powdered catalyst used during the war, this catalyst has very low erosion and attrition rates.

In addition, the microspherical catalyst is much more uniform in particle size than the ground catalyst. Experience has shown that the catalyst make-up rate for replacement of losses and maintenance of activity in a number of commercial units is as low as 0.2 to 0.3 lb. of catalyst per barrel of fresh charge stock.

FLUID CATALYTIC CRACKING 31° A.P.I. MID-CONTINENT GAS OIL (SILICA-ALUMINA CATALYST)

	Once-through	Recycle
Operation:		
Conversion, per cent	60	75
Yields, vol. per cent debutanized:		
Gasoline	45.0	53.0
Cycle oil	40.0	25.0
Butylenes	5.8	7.1
Butanes	8.7	9.4
Propylene	5.2	6.4
Propane	2.4	3.3
C_4 and lighter gas (weight per cent)	2.5	3.1
10-Lb. R.v.p. polymer gasoline	8.0	9.9
10-Lb. R.v.p. catalytic gasoline	47.4	55.8
Total 10-lb. R.v.p. gasoline	55.4	65.7
Octane numbers of 10-lb. catalytic gasoline:		
Motor method, clear (F-2)	81.8	81.8
3 cc. TEL per gallon	86.8	87.4
Research method, clear (F-1)	93.7	94.2
3 cc. TEL per gallon	98.7	99.1

Fluid Catalytic Cracking

PURPOSE.—Production of high-octane gasoline.

Under normal operating conditions, the feed stock is cracked with natural catalyst which converts about 50 per cent of the oil into gasoline.

CHARGING STOCKS.—Feed stocks range from light virgin gas oils to heavy deasphalted reduced crudes and coker gas oils.

The process employs a finely powdered catalyst (either natural or synthetic) which, when sufficiently aerated by air or hydrocarbon vapor, behaves like a liquid. Most of the heat for cracking is produced in the regenerator section of the unit where coke—deposited on the catalyst as a byproduct of the cracking reaction—is removed by combustion with air.

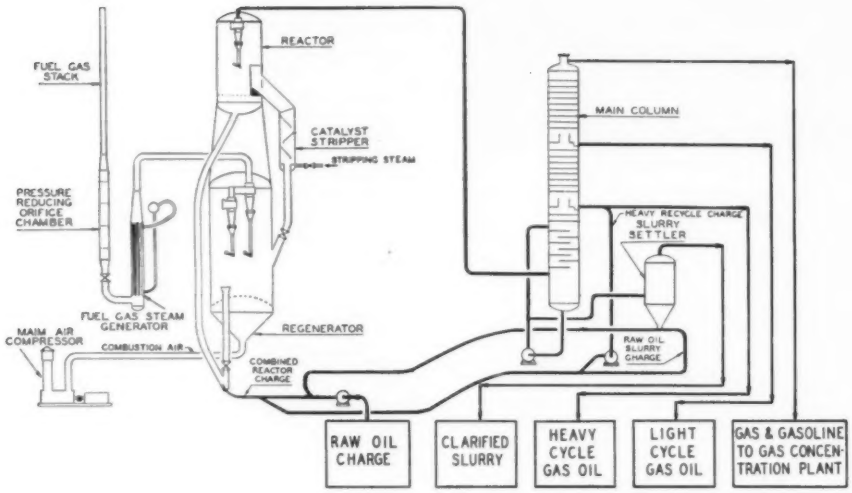
In the reaction vessel, the gas and powder pass through distribution grids into the catalyst bed which is kept in a fluidized, suspended state by the velocity of the gases entering the chamber. Small amounts of catalyst which escape from the bed with the vapor are collected in cyclones and returned to the bed.

Coke, deposited on the catalyst by the cracking reaction, is burned off in the regenerator. A blower supplies this combustion air, a portion of which is used to convey the spent catalyst to the regenerator.

YIELDS AND SPECIFICATIONS

Recycle, per cent of fresh feed	0	50
Conversion, volume per cent of fresh feed	50	65
Product yields:		
Coke, weight per cent	3.2	5.2
Dry gas, weight per cent	5.8	8.2
Butane-butenes, volume per cent	11.8	16.1
Debutanized motor gasoline, volume per cent	38.0	47.3
Total cycle oil, volume per cent	50	35
10-lb. R.v.p. motor gasoline, volume per cent	40.6	50.2
Excess butanes, volume per cent	9.2	13.2
Octane numbers:		
A.S.T.M.—clear	82.0	82.1
C.F.R.R.—clear	95.1	95.1
Total cycle oil:		
Gravity, °A.P.I.	26.8	24.4
A.S.T.M. 50 per cent point, °F.	604	584

Heat supplied by the regenerated catalyst is introduced into the liquid oil stream by means of a



Principal modifications in the new improved unit as compared to the earlier design are:

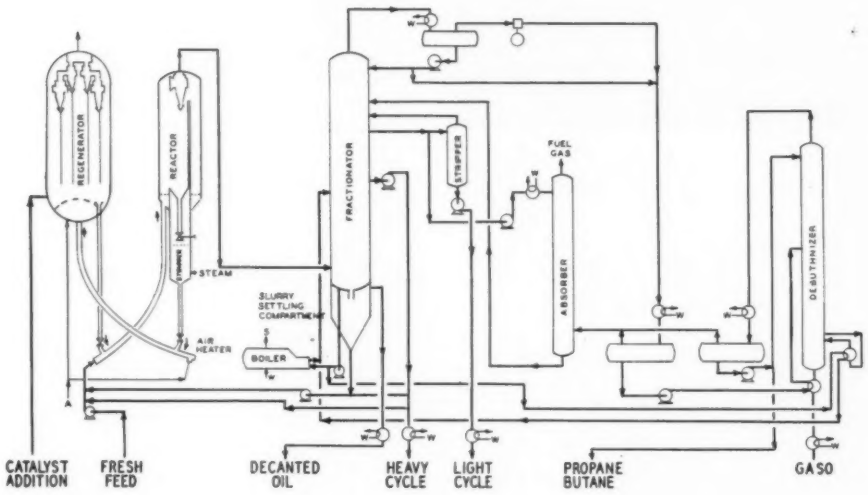
1. In the small-size units the reactor and regenerator have been combined in a single tower which is erected as a self-supported column. The heavy structure required in the earlier units has been eliminated.

2. The large regenerator riser has been eliminated and the regenerator standpipe has been considerably shortened. There have been a general reduction and simplification of small piping.

3. The stripper has been modified to reduce entrained hydrocarbons in the catalyst passing into the regenerator.

4. The air supplied for combustion passes through the regenerator countercurrent to the catalyst. This permits multistage stripping and more complete utilization of oxygen.

Discussion on this process was prepared by its licensor, Universal Oil Products Co., Chicago.



standpipe from the regenerator to the fresh feed carrier line. The hot catalyst contains sufficient heat from the coke combustion to vaporize the preheated oil and crack it in the reactor.

After cracking, the spent catalyst, containing coke and hydrocarbons, is stripped of the latter by steam in a stripper which is an integral part of the reactor. The stripped vapors are vented back into the vapor space over the catalyst bed and thence flow through cyclones to the bubble tower for product separation.

RESULTS. — Product yields and specifications from a typical wide cut Mid-Continent gas oil charge are given in the accompanying table.

Discussion of this process was supplied by the M. W. Kellogg Co., New York.

Houdriflow Catalytic Cracking

PURPOSE.—Production of either motor gasoline or aviation base stock, and light hydrocarbons for synthetic rubber or alkylate manufacture in addition to tractor fuel, distillate fuels, and polymerization feed stocks.

The modified Houdriflow catalytic cracking process, as typified by the units now under construction, adds several innovations to the original Houdriflow design introduced nearly 3 years ago. The newer units share with earlier designs the advantages of truly concurrent and countercurrent flow of catalyst and oil and air inherent in the moving-bed-type process. This feature insures uniform contact with the catalyst of oil in the reactor and air in the kiln and eliminates bypassing of individual catalyst pellets.

CHARGE STOCK.—Potential charge stocks include the full range from kerosene through vacuum gas oils and may include certain reduced crudes having low carbon content. By employing synthetic catalyst and installing corrosion-resisting equipment at critical points, high-sulfur stocks may also be charged. Normally, the charge is preheated to such a degree that it is introduced in a mixed-phase through a distributing nozzle located centrally within the annular curtain of catalyst at the top of the reactor. However, with appropriate design for balancing heat generation and absorption, total liquid or vapor charge streams may be processed.

DESIGN CHANGES. — The important design changes of the modified Houdriflow unit are:

Reactor vapor disengager.—The modified vapor disengaging section is a combination of cup and transverse channel design. Vapors collected in the channels discharge into the annular plenum chamber formed by the swaged outer shell at the bottom of the reactor and a continuation of the straight portion of the reactor shell.

Lift gas.—Flue gas for the lift is provided by a thermocompressor which takes gas from the lower zone of the kiln at 2 psig. and compresses it to about 5 psig., using steam as the motive fluid. Therefore, it is not necessary to compress all of the regeneration air to the higher pressure needed for lift operation and a single-stage blower discharging at 4 to 5 psig., may be used.

Pressure balance. — Kiln pressure-drop relationships have been set to take advantage of the reduced regeneration air pressure. The highest kiln pressure exists at the inlet to the lower burning zone while the top of the kiln is at essentially atmospheric pressure, permitting bypassing and depressuring of the reactor without disturbing normal operation of the kiln and lift.

Intermediate seal leg.—With the top of the kiln

Cycloversion Catalytic Cracking

PURPOSE.—Production of high-quality motor fuels.

Designed on a fixed-bed principle, the process operates with no appreciable loss of catalyst through the formation of fines by abrasion. The Cycloversion process is characterized by its simple, low cost, and flexible operation.

Equipment for the circulation, separation, and recovery of catalyst from the process or reactivation gases is not required. The natural bauxite catalyst employed is capable of regeneration an indefinite number of times, and maintains 85 to 95 per cent of the cracking efficiency exhibited by new catalyst.

CHARGING STOCK.—Gas oil is the feed stock in the production of motor fuel by the process.

PRODUCTS AND YIELDS.—Results on catalytic cracking of two similar types of gas oil are given in the accompanying table.

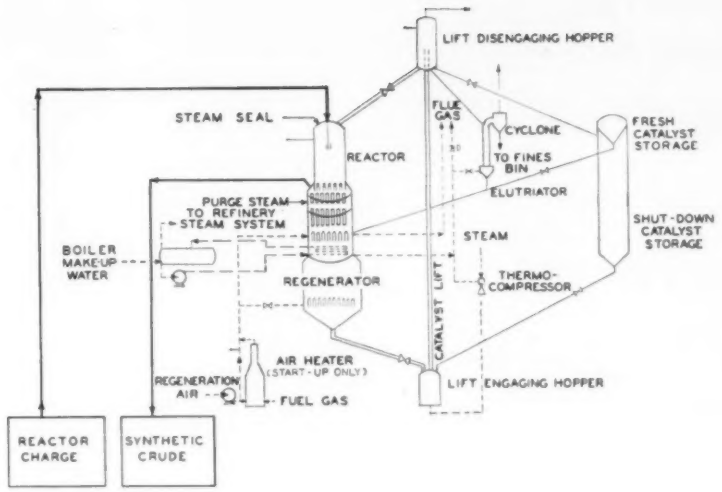
When catalytically cracking gas oil, the fresh or recycle feed is preheated to about 1,000° F. and then is admixed with a small quantity of steam diluent. This steam reduces carbon deposition on the catalyst, assists in vaporizing the charge stock, and improves the octane rating of the catalytic gasoline.

	Operation	
Feed stock (Texas Panhandle gas oil):	10 psi.	85 psi.
Gravity, °A.P.I.	36.9	37.4
10 per cent	552.	501.
90 per cent	697.	709.
Aniline point, °F.	185.	180.
Catalytic gasoline, C_5-400° F.:		
Gravity, °A.P.I.	57.2	56.3
Reid vapor pressure	6.4	6.4
A.S.T.M. octane number	81.5	76.7
3 cc. TEL	85.3	82.4
Research octane number	94.3	87.1
3 cc. TEL	85.3	93.4
Yields, per cent of charge:		
Catalytic gasoline, C_5-400° F. vol. per cent	28.1	33.3
10-lb. R.v.p. gasoline, vol. per cent*	38.7	40.9
Propylene, vol. per cent	5.0	3.7
Butylenes, vol. per cent	7.3	4.3
Catalytic recycle, 400° F. +, vol. per cent	57.8	53.6
Carbon, weight per cent	1.2	1.5
Conversion, single pass, vol. per cent	42.2	46.4

*Butanized and includes potential catalytic poly gasoline.

The superheated oil-stream mixtures passes to the catalyst chamber at the desired operating pressure, usually in the range of 10 to 85 psig., where catalytic cracking is obtained in process cycles of 2 to 10-hour periods.

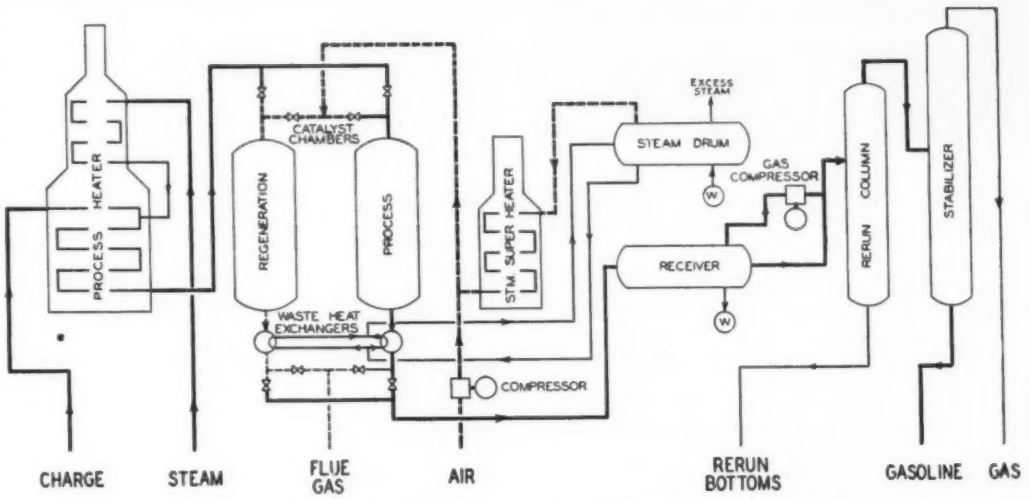
Reactor effluent, after waste-heat exchange for



at atmospheric pressure, the possibility of flowing regeneration air into the reactor in the event of an upset has been minimized. The single seal leg and safety slide valve can then be replaced by multiple seal pipes feeding catalyst directly from the bottom of the purge zone to the top zone of the kiln. The new seal pipes eliminate the reactor bottom catalyst draw-off and kiln top distributing sections, resulting in an appreciable reduction in height and a more uniform distribution of catalyst across the kiln cross-section.

While the modified Houdriflow units have these advantages over earlier units, design simplifications actually result in reduction of initial investment cost and lower operating and maintenance costs for a plant of given capacity.

Discussion on this process was supplied by its licensor, Houdry Process Corp., Philadelphia.



recovery of a large amount of the heat as steam production, passes to additional heat-exchange and condensing equipment.

Total chamber product passes through the oil-water-vapor separator for removal of condensed water, distribution of the vapors to the gas-recovery plant, and distribution of liquid-hydrocarbon condensate to fractionation.

Simultaneously with the processing of the gas-oil charge in the on-steam reactor, the alternate chamber is undergoing catalyst regeneration. Steam from the waste-heat exchangers is superheated to about 750° to 850° F., admixed with air, and charged to the chamber on regeneration. The regeneration gases are passed to waste-heat exchangers and finally vented to the atmosphere through a suitable vent stack.

Discussion on this process was supplied by its licensor, Perco Division, Phillips Petroleum Co., Bartlesville, Okla.

Thermofor Catalytic Cracking

PURPOSE.—Production of high-quality gasolines by catalytic conversion of heavier hydrocarbons.

This new process is a simplified version of the earlier Thermofor catalytic cracking process, developed by Socony-Vacuum Oil Co., Inc.

While the Socony air-lift T.C.C. unit embodies a number of improvements, simplifications, and new developments, it still retains all of the basic advantages of high liquid recovery, high catalyst activity, high cracking efficiency, and high gasoline-to-coke ratio associated with previous T.C.C. operations.

There are three major differences which distinguish this process from the earlier versions. These differences are:

1. The new air-lift unit, as the name implies, employs a pneumatic transportation system for moving the catalyst from the base of the regenerator to the top of the reactor. Approximately 2 years' development effort, including the installation and operation of a full-scale test lift by Socony-Vacuum, forms the background for the new lift-system design. This system is highly efficient and its commercial performance has measured up fully to expectations based upon the earlier operation of the large-scale test lift.

The catalyst attrition rate in Socony's first commercial air-lift T.C.C. unit which, at this writing, has been on stream approximately 3 months, is now approximately 0.75 tons per day per 100 tons per hour of circulation (about 2.0-2.5 tons per day for a 15,000-bbl. per day unit).

2. As the accompanying flow diagram indicates, the unit has the reactor superimposed over the regenerator and has only one catalyst level; that is, the level in the separator surge hopper. This arrangement not only has resulted in a reduction in plant construction cost but it contributes greatly to operating simplicity.

3. Catalyst-to-oil ratio has been moderately increased in the new units, with the result that the carbon concentration on the spent catalyst has been reduced sufficiently so that a greatly simplified regenerator, having only one air inlet and two flue-gas outlets, has resulted. The operation of this regenerator is far simpler than that of the earlier-type T.C.C. unit kilns, since it is necessary to remove heat by cooling coils at only one level. As a result the new air-lift T.C.C. unit can, if desirable, maintain even higher catalyst activity than the earlier T.C.C. units.

CHARGE STOCKS.—Most of the air-lift T.C.C. units are being equipped to charge unvaporizable gas oils and consequently these units will handle all of the gas-oil components in crude oils, ranging from heating oil to asphalt.

Cycloversion Reforming Process

PURPOSE.—Desulfurizes and catalytically reforms cracked and straightrun naphthas, gasolines, or blends.

The normal benefits derived from this catalytic desulfurization process are obtained along with an appreciable increase in clear octane rating. This is effected by some additional mild cracking or reforming as evidenced by the presence of fixed gases in the reactor effluent stream.

Fixed gas losses are relatively low and gasoline yields are high, particularly in view of the C_3 and C_4 components recoverable as poly feed.

Normal operating conditions include chamber pressures from 50 to 100 psig., top-bed chamber temperatures of about 1,000° F., and process cycles of 24 hours or more. The feed is vaporized, and then is superheated prior to passing through the catalyst tower at the reaction temperature. Effluent vapors pass through the feed-product heat exchangers to the rerun and stabilizing towers from which the finished gasoline is sent to storage.

Only a small deposition of carbonaceous material occurs during normal process operation as compared to conventional catalytic cracking. This low carbon deposition on the catalyst permits an operation on relatively long process cycles and low-cost regeneration of the catalyst.

MID-CONTINENT (KANSAS) CRACKED-STRAIGHTRUN GASOLINE
(61.7° A.P.I. gravity; 121°-403° F. boiling range)

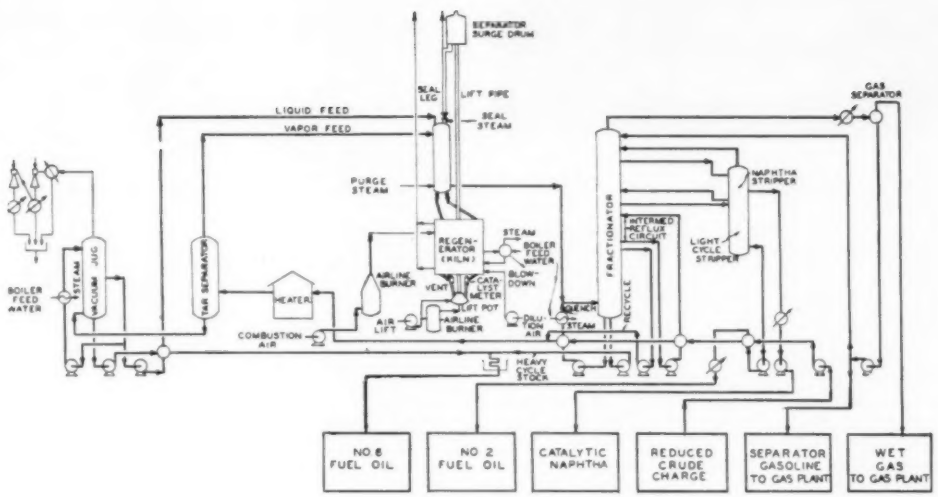
	Raw feed	Cat. reformed*
A.S.T.M. octane number	59.6	70.8
1 cc. TEL	68.4	78.8
3 cc. TEL	75.6	83.6
Research octane number	63.2	75.3
1 cc. TEL	71.4	83.6
3 cc. TEL	81.2	88.8
R.v.p. at 100° F.	4.4	10.6
Total sulfur, per cent	0.039	0.031

EAST TEXAS DISTILLATE
(67.1° A.P.I. gravity; 100°-410° F. boiling range)

	Raw feed	Cat. reformed*
A.S.T.M. octane number	47.8	70.7
1 cc. TEL	59.9	78.4
3 cc. TEL	73.0	83.3
Research octane number	47.0	75.7
1 cc. TEL	57.1	85.1
3 cc. TEL	72.8	90.8
R.v.p. at 100° F.	6.0	8.0

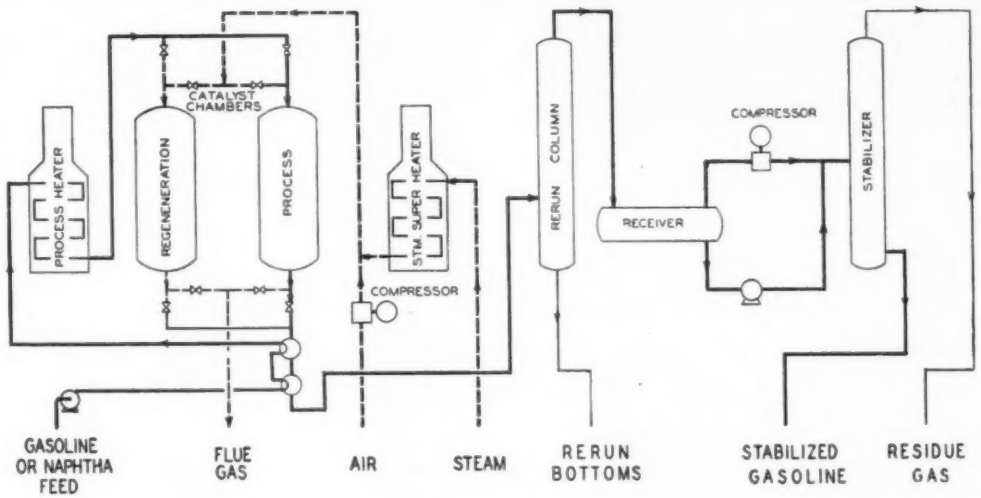
*These catalytically reformed products are C_5 and heavier gasolines and do not contain potential poly gasoline from polymerization of C_3 and C_4 olefins produced.

CHARGING STOCKS.—The process may be oper-



PERFORMANCE.—The commercial performance of the liquid feed system has been proven by nearly 2 years of operation in the T.C.C. unit of Socony-Vacuum's Casper, Wyo., refinery. This refinery is cracking the portion of crude boiling below diesel fuel and before 130° F. soft point asphalt, at approximately 76 per cent conversion level and producing about 61 per cent of 10-lb. R.v.p. catalytic gasoline, plus an additional 10 per cent of catalytic polymer gasoline, while maintaining a propane-free liquid recovery of about 97.5 per cent by volume. The liquid feed has a midboiling point of approximately 870° F. and an A.P.I. gravity of approximately 18.5°. It amounts to about 25-30 per cent of the fresh feed to the unit.

Discussion on this process was prepared by its licensor, Socony-Vacuum Oil Co., Inc.



ated either at catalytic reforming or catalytic desulfurizing conditions and the unit operation is sufficiently flexible to enable refiners to conduct a wide variety of operations on selected fractions or on total refinery gasoline, as may be desired or dictated by economics and finished-product sales.

PRODUCTS AND YIELDS.—Typical Cycloversion catalytic reforming results are given in the accompanying tables. The appreciable increase in "jump" octanes, or the spread between A.S.T.M. and research values indicated in the table is of extreme interest to refiners having only thermal-type equipment. The process is not only applicable to stocks having moderately high total sulfur but also to those stocks having relatively low total sulfur contents.

Discussion on this process was supplied by its licensor, Perco Division, Phillips Petroleum Co., Bartlesville, Okla.

Platforming Process

PURPOSE.—Upgrading motor fuel and synthesizing aromatics.

The U.O.P. Platforming process as shown in the accompanying flow diagram is arranged for motor-fuel operation. The total feed is charged to a prefractionator, where the desired amount of light ends is removed and a small amount of heavy ends is taken off as bottoms. The reactor charge, withdrawn as a sidecut, is heated to the required temperature in combination with the recycle gas and the combined streams pass through a series of reactors provided with interheaters. Effluent from the last reactor passes through heat exchange to a cooler, then to a separator. Part of the hydrogen-rich gas from the separator is recycled through a heater to the reactors, the remainder being taken off as net make. Separator liquid flows to a stabilizer, the bottoms from which are finished gasoline or blending component.

Arrangement of the reactor section of the process for aromatics production is similar to that shown in the diagram. However, in most cases a two-tower prefractionating system would be provided and facilities to separate the aromatics in the desired purity from the stabilizer bottoms are required.

PLATFORMING OF MID-CONTINENT STRAIGHTRUN GASOLINE

	Yield, % of full range 400° F. e.p. charge				F-1 Octane numbers	
	R.v.p.	Vol. (%)	Wt. (%)	B/D	Clear	+3cc. TEL
Prefractionation—						
Charge (full range 400° F. end point)	4.5	100.0	100.0	1,000	49	69
Products—						
Light straightrun	21.4	11.8	9.8	118		
200°-400° F. Platformer charge	1.0	88.2	90.2	882		
Platforming products, % of prefractionator charge—						
C_3 and lighter			8.3			
C_4-plus platformate		83.5	81.9	835		
Blend of light straightrun and platformate—						
Light straightrun component		11.8	9.8	118		
C_4-plus platformate component		83.5	81.9	835		
Total blends	10.0	95.3	91.7	953	87.5	87.0

CHARGE STOCK.—Straightrun gasoline fractions in the 100°-400° F. boiling range are suitable charge stocks. Similar fractions of many cracked gasolines may be added to the straightrun charge, in which event the product will be essentially the same as that derived from straightrun naphtha alone.

Hydroforming Process

PURPOSE.—Converting a low-octane naphtha into a high-octane gasoline.

The conversion or reforming is accomplished largely by means of dehydrogenation and cyclization reactions. These reactions are promoted by a molybdena-on-alumina catalyst at 900°-1,000° F. and 150-300 psig., with a high partial pressure of hydrogen in the reaction zone.

The hydrogen partial pressure is maintained by recycling hydrogen-rich gas to the reaction zone along with the vaporized fresh feed. The process usually produces a large amount of net hydrogen, which makes possible the hydrogen-rich recycle.

CHARGING STOCK.—Naphthenes (cycloparaffins) in the feed stock are dehydrogenated and some molecules are slightly rearranged to form aromatics. Considerable cyclization of straight-chain hydrocarbons also takes place. If any olefins are present, as in the case when some cracked naphtha is included in the feed, these are almost completely converted to paraffins or ring compounds. Over 90 per cent of the sulfur contained in the naphtha is removed.

Hydroforming is carried out in a unit usually having four or more reactors filled with catalyst, half of which are always in series on reaction, and the other half in different stages of regeneration. The reactors are switched from reaction through regeneration and back to reaction in cycles of 8 to 16 hours' duration by an electric cycle controller.

Regeneration is necessary because a small deposit of carbon and a partial reduction of the metal in the catalyst combine over a period of hours to reduce the activity of the catalyst. The carbon is burned and the catalyst reoxidized by combustion.

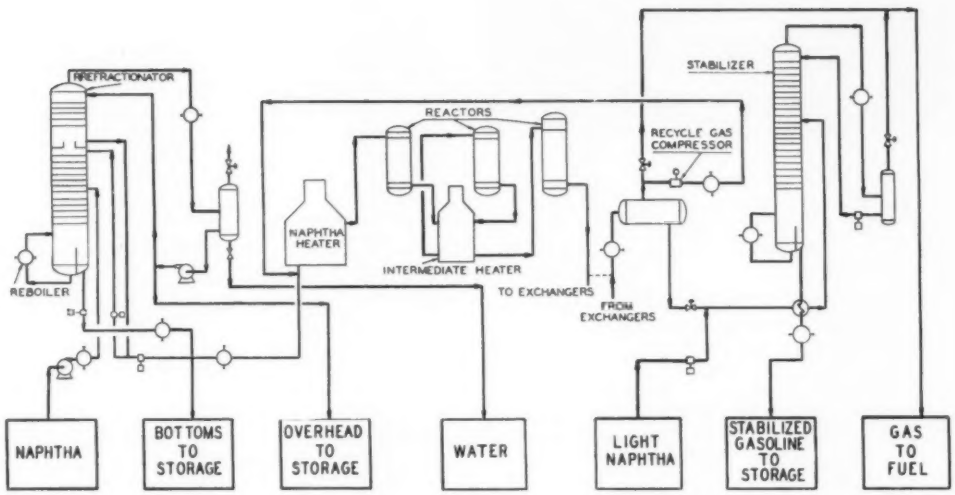
The reaction products are recovered and fractionated into: (1) a hydrogen-containing gas substantially free of hydrocarbons heavier than propane, (2) a highly aromatic "polymer" boiling above 400° F., and (3) a depropanized, 400° F. end-point gasoline.

RESULTS.—Yields of 80-volume per cent of 80 C.F.R.-M octane, 100 per cent C_4 recovery gasoline are obtained, with the remainder of the material going approximately three-fourths to C_4-free gas and one-fourth to polymer and carbon.

When operating to lower octane levels it is possible, by blending in extraneous butanes to the 10-lb. R.v.p. pressure level, to obtain a yield based on feed of 100 per cent of 60-octane gasoline which can be brought up to 80 C.F.R.-M octane by the addition of 1.5 cc. of TEL.

As a typical operation, naphtha is preheated in exchange with hydroformer charge transferring from reactor to cooler, and is introduced into the naphtha heater along with a light hydrocarbon gas-hydrogen mixture; the heated charge enters the reactor contacting the catalyst, a metallic oxide.

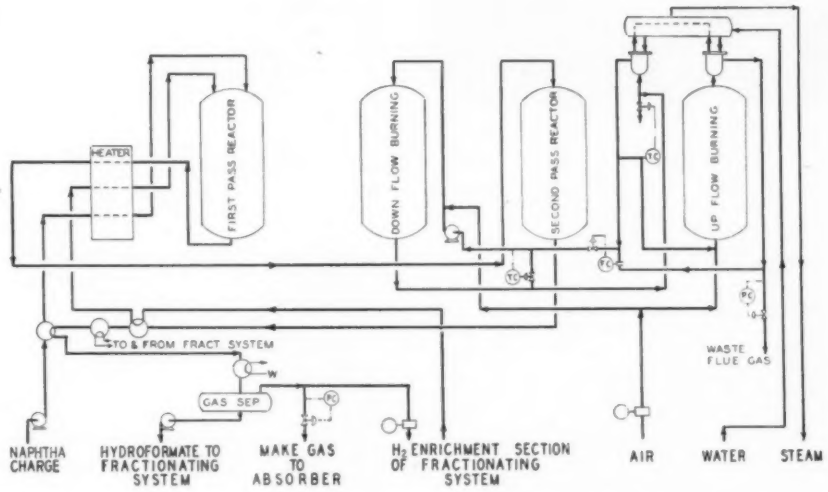
Flue gas and air mixed in the ratio of four or five



The sulfur content of the Platformed gasoline is normally 0.005 per cent or less.

RESULTS.—The process is an efficient method for converting C_5-ring as well as C_6-ring naphthenes to the corresponding aromatics. Isomerization and hydrocracking of paraffins occur simultaneously with the aromatics synthesis, with the result that the residual product after aromatics removal is still of good quality for motor fuel. Production of benzene, toluene, and xylenes in yields approaching theoretical have been demonstrated. Results on Platforming Mid-Continent straightrun gasoline are given in the accompanying table.

Discussion on this process was supplied by its licensor, Universal Oil Products Co., Chicago, which also developed the process.



to one by volume, to dilute the oxygen content, is heated in a separate heater and forced via blower through the spent-catalyst beds.

Part of the hot gases from this regeneration is passed through a reactor in which the catalyst temperature immediately after regeneration is about 700° F. or lower, in order to bring the temperature up to about 950° F. Another portion of the hot gas is passed through a "waste heat boiler."

Although the process is primarily used for converting low-octane naphtha to high-octane motor gasoline it may also be employed for the production of aromatics. During World War II much of the nitration grade of toluene produced in this country was obtained from operation of plants employing this process.

Discussion on this process was supplied by M. W. Kellogg Co., New York.

Catalytic Dehydrogenation

PURPOSE.—Production of monoolefins and diolefins from their corresponding paraffins, diolefins from monoolefins or from mixtures of paraffins and monoolefins, and aromatics with unsaturated side chains from alkylaromatics.

CHARGE STOCK.—In commercial practice operation of the Houdry dehydrogenation process has been limited mainly to the production of butadiene from a mixture of butane and butene and the production of butene from butane. The dehydrogenation of propane to produce propene and the dehydrogenation of ethane to produce ethene is possible but the yields are relatively low because of the unfavorable equilibrium values.

The dehydrogenation is accomplished by passing the preheated fresh feed and the recycle stock from the purification unit over a chrome-oxide on alumina-type catalyst at regulated conditions of space velocity, temperature, and pressure. During the reaction period a large amount of endothermic heat of reaction is absorbed.

In addition to the products of dehydrogenation, a small quantity of fixed gas is produced and coke is deposited on the catalyst. This coke is burned periodically to restore initial catalyst activity. Operating conditions are chosen such that the heat used for reaction is essentially balanced by the heat developed from the combustion of the coke deposit.

The heat capacity of the catalyst bed is controlled by mixing an inert material of granular form having high density and high specific heat with the active catalyst. This inert material functions as a heat storage medium. During the regeneration cycle the heat of combustion of the coke deposit is largely absorbed with a resultant increase in temperature and during the reaction period this heat is released due to the endothermic heat of reaction.

A combination of short on-stream periods and high heat capacity of the catalyst mass insures a limited amount of temperature fluctuation which is necessary for optimum conversion and selectivity. Adjustments in the desired temperature levels are obtained by variation of hydrocarbon and air inlet temperatures.

MAJOR EQUIPMENT.—The process utilizes the principles of the Houdry fixed-bed cracking process, with reactors operating in groups of three. The on-stream period on each reactor is followed by a vacuum purge of hydrocarbons then a regeneration period carried out by circulation of air preheated by direct combustion of fuel in the stream.

At the end of the regeneration period products of combustion also are purged by means of a steam ejector, prior to the following onstream period. Thus in a three-reactor group one reactor received hydrocarbons while the second receives air and the third

Catalytic Reforming Process

PURPOSE.—Conversion of low-octane naphthas into finished high-octane gasoline. The process is also capable of producing substantial quantities of highly concentrated aromatic streams.

CHARGE STOCK.—This may consist of any fractions of crude naphtha up through normal gasoline end point, natural gasolines, cycle products, and mildly thermally cracked naphthas. Prefractionation or rerunning facilities immediately preceding the reaction section are not required in this catalytic reforming process. Sulfur and normal moisture concentrations in charge stocks do not contaminate the platinum catalyst.

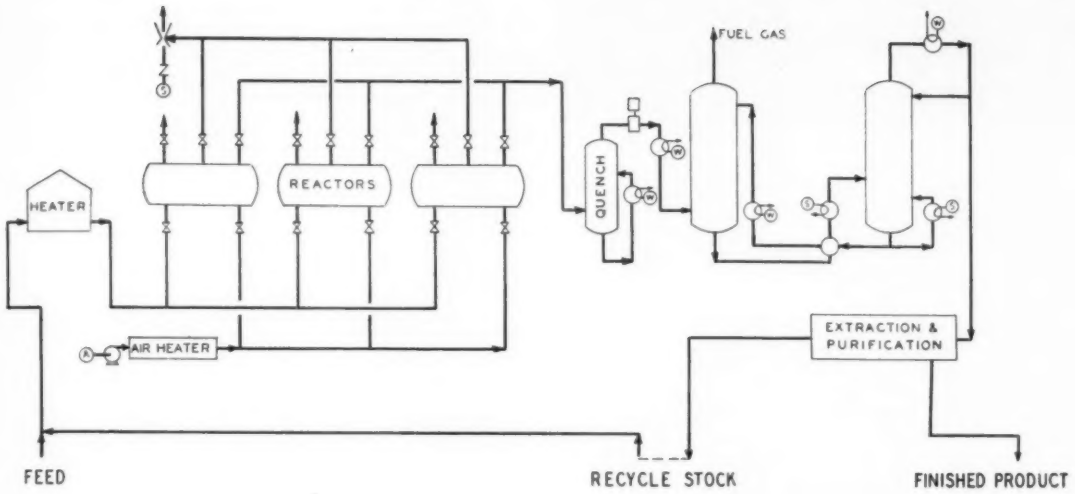
For the synthesis of specific aromatic compounds, such as benzene, toluene, or xylenes, special prefractionation of charge stock may be desirable to obtain selective cuts rich in naphthenes of molecular weights corresponding to desired aromatic product.

With normal operating conditions required for reforming naphtha to motor gasoline, the process is continuous and nonregenerative. Vaporized charge naphtha and a recycle hydrogen stream in volume ratio of 1 to 10 respectively, are passed over fixed beds of the pelletized catalyst at temperatures of 850°-1,000° F. and pressures of 300-700 psig. A balance of catalyst properties and operating conditions has been achieved to yield an optimum combination of the desired isomerization and dehydrogenation reactions while minimizing undesired cracking reactions.

The selectivity of the process is illustrated by the high hydrogen concentration in the recycle gas, averaging 97 to 98 per cent, and in the absence of substantial quantities of methane or other light hydrocarbons produced in the process. In addition to the high yields obtained, the reformate is essentially free of sulfur and olefins such that no treating of the finished gasoline is required.

For production of aromatics, more severe operating conditions are required to isomerize the bulk of C_5 naphthenes to C_6 naphthenes. Dehydrogenation of C_6 naphthenes to aromatics proceeds readily. The higher severity required for substantial conversion of naphthenes to aromatics will result in a gradual decline in catalyst activity due to carbon laydown. The process provides for periodic regeneration of catalyst in place, as desired.

RESULTS.—The process shows a high yield-octane relationship in reformate. Unleaded East Texas naphtha shows an antiknock-quality improvement of from 54.5 to 85.0 octane numbers, C.F.R.R. with yields of 88.6 volume per cent of C_5 plus and 94 volume per cent of C_5 plus. Over 60 per cent of C_5 production is in the form of isobutane. Conversion of 88 per cent of naphthenes in crude charge to aro-

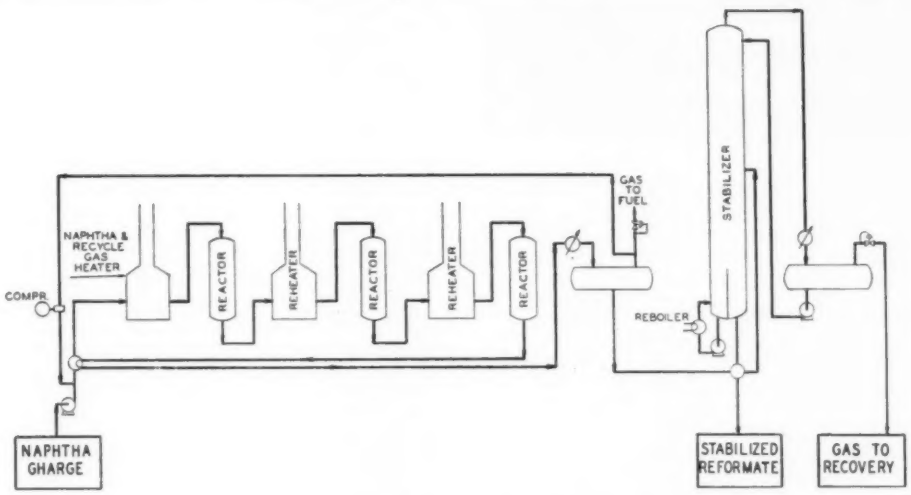


undergoes valve changes and purging operations. By these means, continuous flow of air and hydrocarbons is achieved. In most instances the onstream and regeneration periods are limited to 8-10 minutes each and the additional 8-10 minutes is utilized for valve changing, purging, and repressuring.

Motor valves are operated by a cycle timer and electrical interlocks preclude operation of a particular valve if the operation of the preceding valve has not been completed.

The products of reaction are cooled, separated from the fixed gases, and purified in equipment of conventional design, unconverted material being returned as cycle stock to the process.

Discussion on this process was supplied by its licensor, Houdry Process Corp., Philadelphia.



matics in finished product are possible in this process.

Raw naphtha charge for average high-octane motor-fuel production is preheated to 950° F. and charged to the first in a series of reactors operating in excess of 500 psig. Because of the endothermic nature of the conversion reactions, reheat furnaces are required between reactors.

High-purity hydrogen gas is compressed and recycled with fresh charge. Net gas production comprising over 95 per cent hydrogen plus very small quantities of methane and ethane and H_2S, are withdrawn as fuel.

Liquid reformate is stripped of propane and butanes in a single stabilizer. Stabilized reformate required no further treating because of the absence of sulfur and unsaturated gum-forming compounds.

This process is licensed by Atlantic Refining Co., Philadelphia.

Thermal Cracking

PURPOSE.—Production of gasoline from a wide variety of charging stock.

Thermal cracking also produces butylenes and propylene which can be polymerized to produce polymer gasoline of high octane number for use as a blending fluid to improve the quality of gasolines.

TWO-COIL UNIT.—In this operation the topped or reduced crude charge is introduced to the side of the fractionating column where it is contacted with vapors from the flash chamber. Overhead product from the fractionating column is gasoline.

Furnace or tractor distillates are withdrawn as sidecuts and stripped to specifications. From a lower sidecut tray a higher-boiling distillate comprising lower fractions of both recycle and charging stocks is withdrawn as charge to the light oil heater.

The charge to the heavy-oil heater is withdrawn from the bottom of the fractionating column, and consists of the highest-boiling fractions of both the recycle and charging stocks.

The mixture leaving the reaction chamber enters the flash chamber in which a fuel-oil residuum of the desired properties is separated.

With the U.O.P. Equiflux heater it is possible to obtain temperatures as high as 920° F. in the middle of the reaction chamber. With a reaction chamber operation at this temperature level the heavy charge is subjected to greater time-temperature action than can be achieved without the use of the reaction chamber as a means of viscosity breaking.

Cracking residual stocks at high-temperature levels results in cracked fuel oils of maximum stability

YIELDS

	Max. gasoline	Max. furnace oil
Per cent by volume of charge:		
Gasoline, 400 e.p., 10 R.v.p.	53.5	38
Furnace distillate	...	23
Fuel oil	37.5	34
Liquid volume loss	9	5
Gas. cu. ft./bbl.	500	290
Octane number (A.S.T.M.)	69-70	68-69
Fuel oil, vis., S.F.S. at 122° F.	200	200
Fuel oil, gravity, °A.P.I.	7	8
Per cent catalytic polymer gasoline, 10 R.v.p.	5	3.5
Per cent total gasoline, incl. polymer	58.5	41.5
Octane number of total gasoline	71-72	70-71

In considering these results, it must be remembered that not only the gravity but also the viscosity of the charge are important in determining yields.

It should be noted that the cracked-gasoline yields are all reported on the basis of 400° F. end point and 10 lb. R.v.p. On the basis of total butane-butylene retention in the gasoline the yields would be increased approximately 4 per cent and 3 per cent, respectively. The yields of catalytic polymer gasoline shown in the table are on the basis of polymerizing 80 per cent of the propylene and butylenes formed in the cracking operation.

Vis-Breaking and Pour Reduction

PURPOSE.—The combination process of viscosity breaking and pour reduction is employed to improve the viscosity and the pour of residual oils with a minimum production of fuel oils and maximum production of gas oil.

CHARGE STOCKS.—Low-viscosity fuel oils are produced from charge stocks of high viscosity and low pour point. The characteristics of the charging stock, the required products specifications, and the scope of refinery operations, determine the selection of the particular scheme of operation.

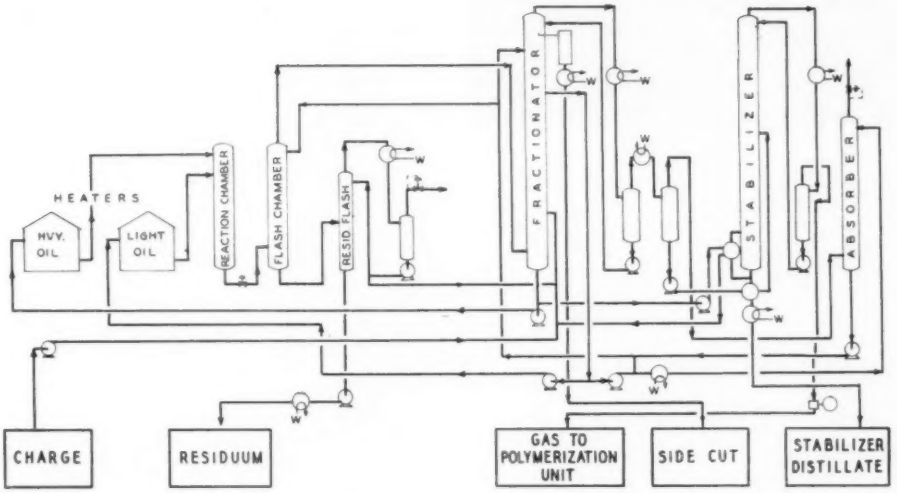
The Lummus two-stage unit shown in the accompanying flow diagram has a wide range of operating flexibility. It is designed to process high-pour-point, high-sulfur-content reduced crude to minimum yields of low-pour-point, low-viscosity fuel oil and maximum yields of low-pour-point cracked gas oils. One coil is used for once-through vis breaking of the reduced crude and the oil coil is used for reducing the high-pour heavy gas oil produced in the first coil. Alternately, for a recycle vis-breaking operation, both coils may be operated in parallel.

A design feature incorporated in this unit is the vacuum flash tower. In this tower the evaporator bottoms are reduced to a heavy pitch which is cut back with light cycle gas oil to produce a low-viscosity fuel oil. The two side cuts which are taken from the bubble tower are charged to the light and heavy-gas-oil strippers. The bottoms stream from the light-gas-oil stripper is the light cycle blending stock which is used to cut back the vacuum tower bottoms to make a low-viscosity fuel oil. Heavy-gas-oil stock is produced as the bottoms product from the heavy-gas-oil stripper. The overhead from both strippers and the vacuum flash tower are combined and returned to the bubble tower.

The high-pour-point and waxy vacuum-tower side cut is returned to the bubble tower, where it is combined with the charge to the gas-oil cracking coil. In this coil the pour point is reduced by 40°-50° F. After cooling, the noncondensed portion of the bubble tower overhead is fed to the absorber and contacted against a slip stream of the heavy gas oil. Bottoms stream from the absorber is recycled to the bubble tower. Condensed bubble-tower overhead feeds the stabilizer.

RESULTS.—When heavy reduced crudes with gravities of 12.0° to 16.0° A.P.I., viscosities from 300 to 800 S.S.F. at 122° F., and pour points of 70° to 100° F. are processed in the two-stage unit, a finished fuel oil with a viscosity of 125 S.S.F. at 122° F. and a pour point of 20° to 25° F. is produced.

Aside from the relatively low yields of low-viscosity fuel oil and high yields of low-pour-point gas oils, this unit in addition produces approximately

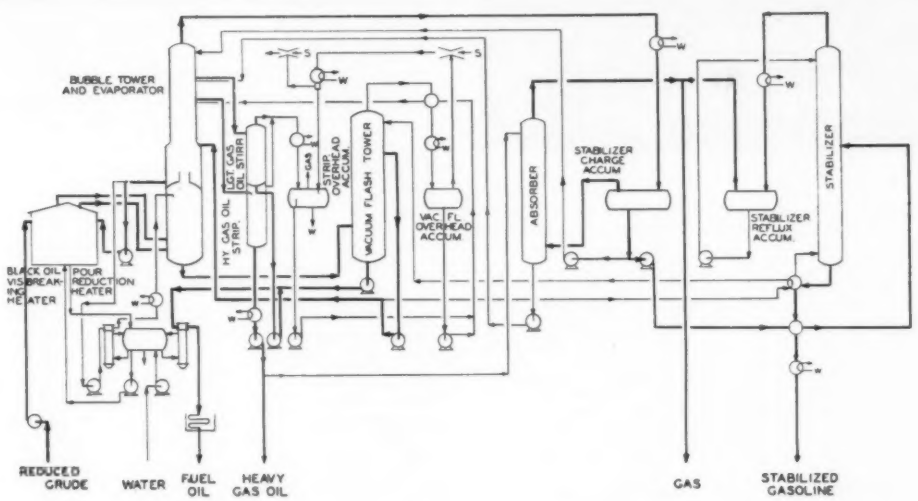


and minimum sediment content. These properties are direct functions of the average temperature level of cracking, and in the modern two-coil unit the average temperature of the entire reaction chamber is greater than the maximum temperature ordinarily attained in coil-only viscosity breaking.

SINGLE-COIL UNIT.—This operation is similar to the two-coil unit with the exception that recycle and fresh charge are cracked in one heater.

RESULTS.—Yield data on processing a 25° A.P.I. Mid-Continent reduced crude oil in residuum operation are shown in the accompanying table. Viscosity, 20 S.F.S. at 122° F.

Thermal cracking processes are licensed variously by Universal Oil Products Co., Chicago, M. W. Kellogg Co., New York, and other licensors. Universal Oil Products Co. supplied this discussion.



20 per cent by volume of 10-lb. R.v.p. gasoline, having an A.S.T.M. octane number of 70 when using naphthenic stocks. If the available residual charge stocks have a low pour point but a high viscosity, the production of low-viscosity fuel oil can be accomplished in a simple once-through operation.

Typical products and yields for a two-stage viscosity breaking and pour reduction unit processing 12,000 bbl. per stream day of 14.8° A.P.I. California reduced crude are:

7,500 bbl. per stream day of 7.9° A.P.I. fuel oil.

1,460 bbl. per stream day of 27.4° A.P.I. heavy gas oil.

2,780 bbl. per stream day of 63.8° A.P.I. stabilized gasoline.

2,450,000 cu. ft. (standard basis) per stream day of fuel gas.

Discussion on this process was supplied by Lummus Co., New York.

Delayed Coking Process

PURPOSE.—Convert heavy hydrocarbons to lighter and more valuable products.

The modern delayed-coking process is operated on a continuous-throughput basis. Operation differs from that of the usual thermal cracking process in that the topped crude, which is heated rapidly, flows to the coking drum where it is coked by its contained heat.

Feed stocks for catalytic cracking may be prepared in the process. Such stocks are shown to be of high quality and eminently suitable for this type of operation.

CHARGING STOCK.—When processing a normal 30 to 40 per cent reduced crude, the charge is heated to 900° to 975° F. and transferred to the coke drums.

These coke drums are maintained at temperatures up to 900° F. While the light fractions vaporize and pass into the fractionator, the heavier oil is subjected to a long-time soaking period during which a decomposition of this heavier oil into lighter fractions and coke occurs.

Two or more drums may be used in sequence. When a drum is full of coke, it is disconnected and replaced by an empty drum. Usually the removal of coke is effected by means of hydraulic decoking which cuts the coke from the drums through the use of high-pressure water jets.

Reduced crude from the topping unit is charged to the base of the delayed coker fractionator. The reduced crude plus recycle is removed as bottoms and charged to the furnace where it is quickly heated to a high temperature and discharged into an insulated drum held at 10 to 60 lb. pressure. Here it cokes by contained heat.

For a typical charge, approximately 12 per cent by weight of the reduced crude goes to coke, 4 per cent to gas, and the remainder to light liquid products.

A specially designed transfer manifold makes it possible to feed any of the coke drums without leaving "dead" space in the line where the hot charge might lie stagnant and coke. In the modern installation, enough drums, which are filled in rotation, are provided to allow a continuous operation.

	Reduced crude			
Feed stock—	Mid-Continent	East Texas	Producers Calif.	South American
Reduced crude on crude, %	30	30	92.5	63
Conradson carbon	6.0	8.0	6.2	11.4
Yields basis reduced crude:				
Gas, wt. %	4.0	4.7	4.8	6.9
Gasoline (400° e.p.-100% C_4), vol. %	19.0	21.0	12.2	20.6
Gas oil (875° e.p.) vol. %	74.0	70.0	76.5	63.4
Coke, wt. %	11.0	12.5	12.9	20.6

Continuous Contact Coking

PURPOSE.—Conversion of heavy residuum oils and tars into coke and valuable light-hydrocarbon products.

The continuous contact coking process offers an economical method of converting reduced crudes into maximum yields of cracking stock readily convertible into high-quality gasoline. It minimizes fuel-oil production and releases valuable distillates currently used for fuel-oil blending. Essentially the process consists of applying a residual stock to a continuous stream of preheated coke particles produced in the process.

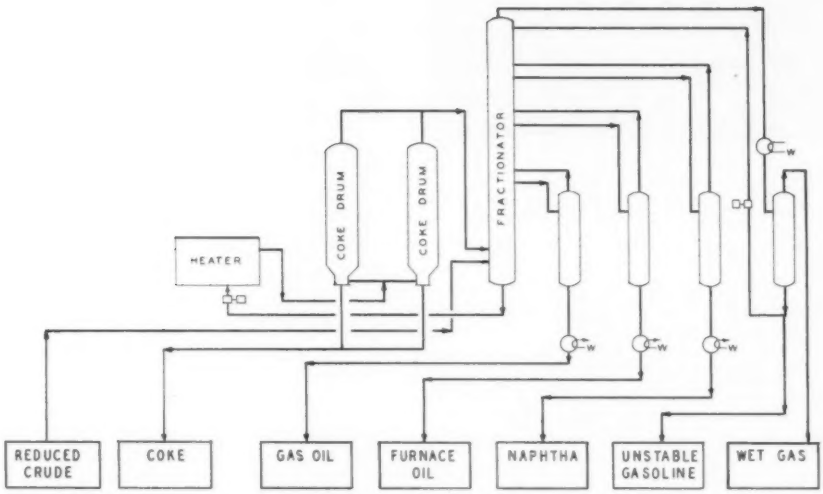
CHARGING STOCK.—In operation of the unit, reduced crude is charged to the bottom section of the synthetic tower. Any material boiling in the desired product gas-oil range is directly distilled. The reduced crude and recycle from the bottom of this tower is preheated in a conventional oil heater to a normal temperature of 800° to 850° F. The preheated oil charge is then thoroughly contacted with the circulating stream of preheated coke particles. The contacting zone is located at the top of the reactor. The temperature of the wetted coke after application of charge oil may be varied from 850° to over 1,000° F. by changing the preheat or the rate of circulation of the coke.

COKE PRODUCTION.—The hydrocarbon oils are distributed uniformly on the coke as a thin liquid microfilm without agglomeration of the circulating solids. The wetted coke particles flow uniformly through the reactor as a bed of free particles. The solids residence time in the reactor may be varied from 15 to 40 minutes, allowing the coking reaction to proceed gradually to complete conversion of liquid hydrocarbon to produce vapors and dry coke.

Coke is deposited as a very thin layer on the original coke particles. The coke stream passes from the bottom of the reactor through a sealing zone into a reheater, where it is heated by radiation and convection to the proper temperature for recirculation to the oil feed contact zone. The coke is recirculated by means of a vapor-lift system.

Since the coke is deposited as multiple thin layers and subjected to partial calcination in the reheater, it is high in density, low in volatile matter, and high in mechanical strength. As the coking operation proceeds, there is an increase of coke inventory in the system and a general increase in particle size. Constant inventory is maintained by continuously drawing off a net coke product stream of the largest particles.

LIGHT PRODUCTS.—The vapors from the reactor are removed at the top, adjacent to the coke inlet, or at an intermediate level in the bed, and are quenched by the heavier recycle stream. The vapors are further fractionated in a conventional low-



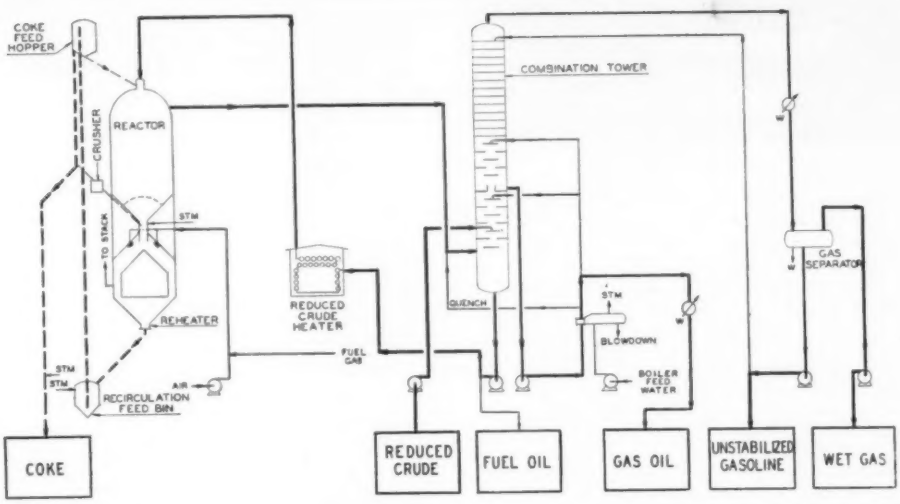
The actual number of drums required is determined by the feed rate and carbon-forming characteristics of the reduced crude.

The vapors from the drums are fractionated in a bubble tower, taking gas and gasoline overhead and withdrawing gas oil (cat cracker feed) as a side-stream. Heavy ends from the fractionator are recycled back through the furnace in admixture with the fresh feed.

RESULTS.—The octane ratings of the motor-fuel fractions from coking operations vary with the characteristics of the feed stocks. Asphaltic, naphthenic, and similar charges will yield motor fuels with an octane (motor method) of 70-73. Paraffinic stocks will show gasoline of 60-64 octane or slightly higher.

Some typical yields of the delayed coking process are given in the accompanying table.

Discussion of this process was supplied by M. W. Kellogg Co., New York.



pressure tower to produce gas and gasoline overhead, 400° to 900° boiling-range gas oil and bottoms. The bottoms are recycled to the coking reactor.

RESULTS.—Since the charge to the contact coker is not subjected to the elevated heater outlet temperatures involved in conventional delayed coking, the product gas oil is subjected to a minimum of thermal cracking. This results in a catalytic cracking charge of a quality very nearly equal to a virgin stock and permits optimum yields and minimum coke formation on subsequent catalytic cracking. Continuous contact coking process produces more gas oil of superior quality and less coke than do conventional coking methods operating on the same charge stock. The continuous contact coker has an unusual degree of flexibility.

Discussion on this process was supplied by Lummus Co., New York.

Catalytic Polymerization Process

PURPOSE.—Convert a portion of fuel gas produced in cracking operations into a high-grade motor gasoline which increases the yield of gasoline obtainable from each barrel of crude oil processed.

The catalytic polymerization process, in effect, produces a finished gasoline of high value from a raw material which has the lowest value.

Polymerization of the butylenes in the absence of other olefins can be controlled to yield a product which on hydrogenation will rate 90-95 octane number. This is referred to as a selective polymerization operation used to produce aviation-gasoline components.

Polymerization of propylene and butylenes in a mixture for the production of a fuel which will be blended in motor gasoline is referred to as a nonselective operation. This is the most common of all polymerization operations.

Propylene can also be polymerized separately to make either a motor polymer or a product rich in either C_6, C_9 or C_{12} polymer, depending on operating conditions. C_{12} or "Tetramer" is one of the raw materials for many detergents.

Briefly, the polymerization operation is one which consists of contacting the olefin-containing feed stream with the catalyst at temperatures in the range of 350° to 425° F. and at pressures ranging from 250 to 1,200 psi. Processing conditions vary with the type of plant employed, with the feed stock processed, and with the type of product desired.

CHAMBER-TYPE PROCESS.—There are two types of units now being used for carrying on the process of polymerization. The most commonly used design is known as a chamber type. In this unit the catalyst is contained in a vertical chamber. Catalyst is loaded in one or more chambers, each containing multiple catalyst beds of 2 to 8 ft. in depth.

Since the polymerization reaction is exothermic and the system in which the reaction takes place is essentially adiabatic, the temperature of the reactants increases as they travel through the catalyst beds.

In order to keep the temperature rise through the catalyst beds at an optimum for good olefin conversion and catalyst life, it is desirable to control the amount of reaction that occurs in the catalyst chamber by the recycling of hydrocarbons which have been through the catalyst chambers. This recycle material, being low in olefin content, will act to dilute the olefins in the fresh feed. In order to hold a given temperature at the inlet to each bed a liquid quench is injected between beds.

REACTOR-TYPE PROCESS.—A unit of this type employs heat-exchanger-type reactors. In this design the catalyst is loaded in vertical small-diameter tubes which are surrounded with a cooling medium to remove heat of reaction.

Reaction temperature control is therefore obtained

Isomerization Process

PURPOSE.—Conversion of normal butane to isobutane to augment supplies of the latter for production of alkylate for aviation-gasoline blending. The process is also applicable to production of isopentane from normal pentane and for improving the octane number of hexane fractions.

In this process a dry feed and anhydrous hydrogen chloride (a promoter for the isomerization reaction) are passed over a catalyst which contains aluminum chloride. The reactor product passes to a tower where the unconverted hydrocarbons are separated and recycled to the reactor. Isomerized product and hydrogen chloride are separated in a second tower, the hydrogen chloride returning to the reactor. The isomerized product is then scrubbed with caustic solution.

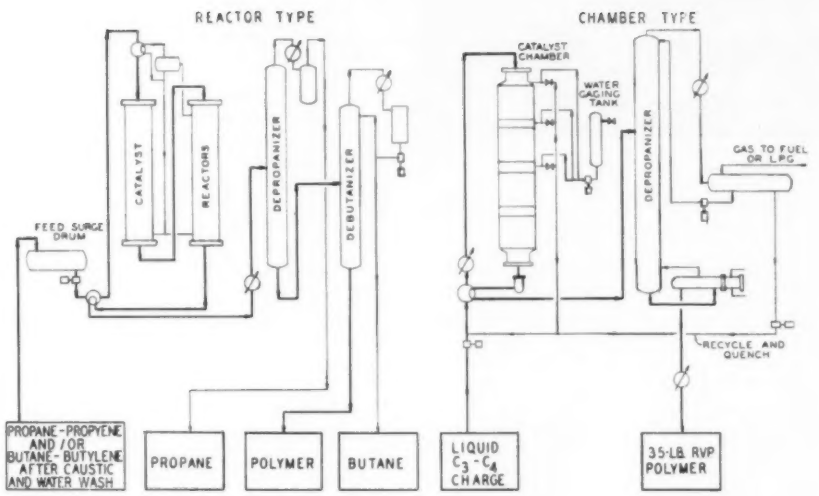
Catalyst activity is maintained by adding aluminum chloride to the reactor, using a portion of the feed as a carrying medium.

The process is operated at pressures in the order of 200-350 psi. and temperatures of 180° to 220° F.

CHARGING STOCKS.—Where normal butane or normal pentane is converted to the corresponding

ISOMERIZATION RESULTS FOR NORMAL BUTANE, PENTANE, AND HEXANE FEEDS

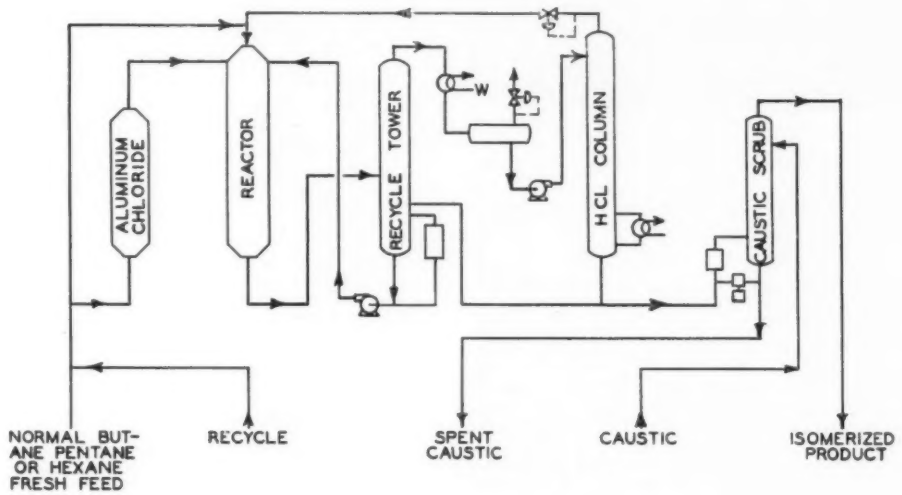
Type of feed—	n-Butane	n-Pentane	Hexane fraction
Operating conditions:			
Reactor temp., °F.	190	180	180
Reactor pressure, psi.	250	250	250
HCl in reactor feed, mol per cent	7-10	7-10	7-10
Product analyses:			
Isobutane	50		
Normal butane	48		
Isopentane		60	
Normal pentane	2	38	
Hexane and heavier		2	
Octane ratings:			
Feed A.S.T.M. O.N. clear			58-60
Product A.S.T.M. O.N. clear			75-80
3 cc. TEL per gallon			88-93
Catalyst consumption:			
Lb. $AlCl_3$ per barrel iC_4 or iC_5 produced	0.3-0.5	0.5-0.7	
Lb. HCl per barrel iC_4 or iC_5 produced	0.05	0.05	



by controlling the temperature of the cooling medium, and in this manner the reaction approaches isothermal conditions. Reactor-type units are most commonly used when the feed to be processed is high in olefin content such as is the case for C_3 and C_4 fractions produced from catalytic cracking.

Control equipment in each process includes the major items of temperature, pressure, and flow recorder-controllers. Over-all instrumentation for both chamber and reactor-type units is reduced to the minimum necessary to obtain desired operational balance. Secondary control apparatus for either process includes simple regulators, temperature indicators, and the like.

Discussion on this process was supplied by its licensor, Universal Oil Products Co., Chicago.



isocompound the recycle stream is the normal hydrocarbon. Where maximum octane number is desired in hexane isomerization, monomethyl pentanes as well as normal hexane are recycled in order to obtain maximum concentration of dimethyl butanes in the products.

RESULTS.—Typical yields and operating conditions for this process are given in the accompanying table.

Discussion on this process was supplied by its licensor, Universal Oil Products Co., Chicago.

XUM

Hydrofluoric Acid Alkylation

PURPOSE.—Catalytically combine olefins, such as propylene, butylenes, and amylenes with an isoparaffinic hydrocarbon, usually isobutane, to form a mixture of branched chain hydrocarbons of higher molecular weight.

Known as alkylate, the product of reaction boils in the gasoline range. Its octane number depends on feed character and operating conditions. Because alkylate has good lead susceptibility and high heat value, it is an ideal blending component for motor and aviation gasolines. Yield and consumption of isobutane vary slightly with the olefin charge and operating conditions.

CHARGING STOCK.—The U.O.P. HF (hydrofluoric acid) alkylation process is carried out essentially as follows: Fresh feed, prepared by absorption and fractionation of the light gases from catalytic cracking and related processes, is dried by fractionation or by means of a desiccant. The stream then flows to the reactor where intimate mixing with the acid catalyst and recycle isobutane is provided under sufficient pressure to keep the mixture in liquid state. Normally, the ratio of acid to hydrocarbon in the reactor is 2 to 1 and the ratio of isobutane to olefin entering the reactor 5 to 1 to 10 to 1.

RESULTS.—The alkylate so produced is a mixture of saturated, stable isoparaffinic hydrocarbons distilling in the gasoline range. By refrigerating the reactor to 60° the knock ratings reach 109 F-3 with 4.6 cc. TEL and 151 F-4 with 4.6 TEL. Because of its high octane number the alkylate is used as the main component of 115-145 aviation gasoline as well as of 100-130 aviation gasoline. During peace time it is also added to motor gasoline for octane appreciation.

Temperatures used in the reaction zone vary from 60° to 100° F. depending upon whether refrigeration or water cooling is used. Cooling of the reaction mixture is necessary since the alkylation reaction is exothermic.

The reactor effluent, consisting of unreacted light hydrocarbons, alkylate, and acid, is permitted to separate into hydrocarbon and acid phases. Substantially complete separation is obtained by settling and the settled acid is recycled to the reactor. The hydrocarbon phase will contain some dissolved acid which is removed by fractionation. The dissolved hydrofluoric acid is recovered as an overhead product in fractionation and is returned to the reaction system.

Some heavy polymers are formed in the alkylation reaction but the catalyst has the advantage that it can be regenerated. The heavy polymer may be

Sulfuric Acid Alkylation

PURPOSE.—Unite light molecules into a high-octane, low-volatility product, boiling within the gasoline range. The product, alkylate, can be added in any proportion to refinery gasoline to improve its quality.

During World War II, this process was primarily used to produce aviation alkylate from butylene and isobutane, commonly known as C_4 alkylation. However, the process is not limited to C_4's. Potentially, any combination of olefinic light hydrocarbons may be combined with isobutane, with the final octane rating being more or less determined by the type of isohydrocarbon in the product.

Although, due to the present emergency, alkylation is naturally undergoing a revival as a wartime tool, it has also been subject to increased investigation as a means of raising the octane of automotive gasoline.

Barring any radical change in automotive engine design, indications are that the octane rating of premium motor fuels will reach or exceed the 95 research level (once the international situation settles down). With increased importance being assigned to the control of spread between motor and research ratings in high-octane blends, alkylate with its narrow spread may well be an essential ingredient in premium fuel.

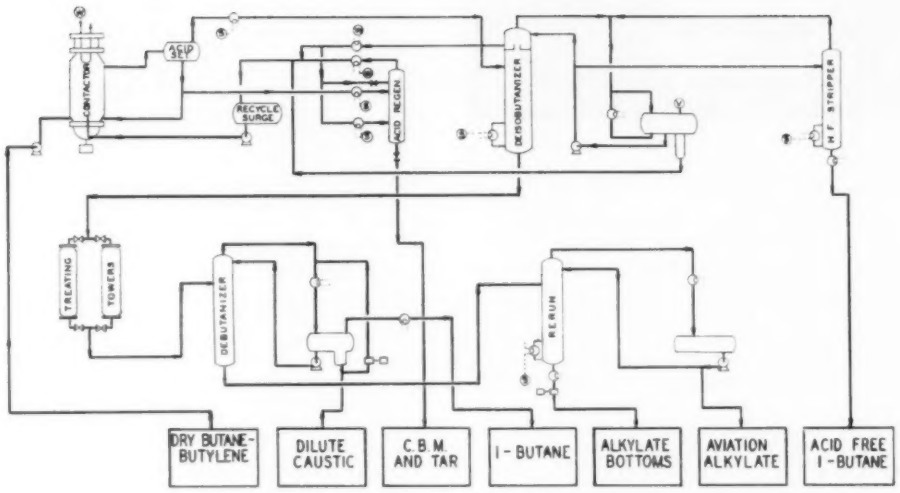
CHARGING STOCK.—In the process, the raw materials are light refinery gases which are high in octane rating but so volatile that only a portion of the amounts available at most refineries can be blended directly into motor gasoline.

The liquefied gases are introduced into a reaction chamber in the presence of concentrated sulfuric acid (98 per cent) which acts as a catalyst. During the reaction, which generally proceeds at a temperature between 38° and 40° F., the sulfuric acid drops in concentration due to dilution by moisture in the liquefied gas stream and side reactions with "impurities" in the feed.

The acid is continuously withdrawn as it be-

TYPICAL YIELDS AND INSPECTIONS

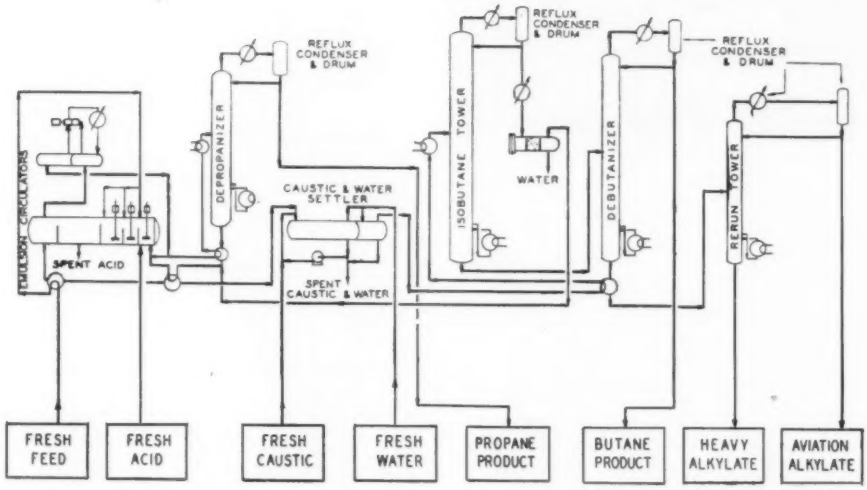
Olefin feed	C_3	C_4	C_5
Alkylate yield: Volume per cent on olefins	175	172	155
Acid consumptions (approximate) lb./gal. total alkylate 98 per cent fresh—90 per cent spent	2.0	0.6	1.0
Octanes—aviation alkylate A.S.T.M. octane No. clear	90	94	91
F-3 or 1-C octane No. + 4.6 TEL	106	108	107
F-4 or 3-C Blending index No. + 4.6 cc. TEL	140-145	155-160	145-150



removed from hydrofluoric acid by fractionation and stripping, which continuously return a purified acid to the reaction zone. There is, therefore, no acid-disposal problem.

After removal of the dissolved acid, the hydrocarbon stream is further fractionated to separate the unreacted hydrocarbons, an isobutane recycle stream, rerun alkylate, and a heavy alkylate which will be a small percentage of the total alkylate produced depending on the end point desired on the rerun alkylate.

Discussion on this process was supplied by Universal Oil Products Co., Chicago.



comes "spent." This is customarily at a concentration of about 90 per cent, though it is widely variable. Fresh acid is regularly introduced to keep the quantity and concentration of acid in the reactor constant. The product of the reactions is passed through a caustic wash and then fractionated at higher temperatures.

RESULTS.—From a motor-gasoline quality standpoint, it makes little difference whether the alkylate is made from C_3, C_4, or C_5, although the economics will vary. Propylene and butylene are the only feeds that will interest the average refiner. However, C_5 alkylation may well be of interest to the operator of a natural gasoline plant.

Yield and inspection data for operations on C_3, C_4 and C_5 charging stocks are given in the accompanying table.

M. W. Kellogg Co., New York, supplied this discussion.

Liquid-Phase Isomerization

PURPOSE.—Isomerization of either butane or pentane.

In the Shell liquid-phase isomerization process, which is entirely continuous and nonregenerative, normal butane or normal pentane is contacted in the liquid state with a catalyst consisting of aluminum chloride dissolved in molten antimony trichloride.

CHARGING STOCK.—Either butane or pentane may be converted to the corresponding isoparaffin in the same plant. The only additional equipment required for converting the C_5 hydrocarbon are the hydrogen compressor and its surge. The compressor can be eliminated, however, if a source of hydrogen at the desired pressure is available so that it can be used on a once-through basis.

The feed hydrocarbon is mixed with dry hydrogen chloride gas which acts as a catalyst promoter. In addition, when pentane is isomerized by this process, it is necessary to introduce a disproportionation suppressor such as hydrogen along with the HCl, as disproportionation reactions, if not controlled, would result in a low ultimate yield of isopentane and high catalyst consumption.

In operation, the normal paraffin is charged continuously, at approximately atmospheric temperature, to one of two driers. Temperature of the dried feed is raised to about 180° F., before entering a packed catalyst scrubber column. Here a small side stream of catalyst from the contactor is countercurrently extracted with the feed.

The valuable active catalyst components are returned to the contactor in solution. The essentially inactive $AlCl_3$-hydrocarbon complex, formed as a result of side reactions, settles to the bottom of the column and is periodically drawn off.

EQUIPMENT.—The feed stream, containing recovered aluminum chloride and antimony trichloride, flows from the top of the catalyst scrubber column and is joined with recycle hydrogen chloride and, in the case of pentane isomerization, recycle hydrogen prior to entrance into the reaction vessel.

The contactor is a vertical autoclave fitted with a mixing device to effect intimate contact of catalyst and hydrocarbon. Period of contact is relatively short, the charge remaining 10 to 15 minutes in the contactor. A high conversion is obtained; 50 per cent or better for butane and 55 to 60 per cent for pentane. Separation of the isomerate from the catalyst takes place in the baffled upper section of the contactor phase.

From the contactor the converted hydrocarbon stream flows to the catalyst column for separation and recycle of the dissolved catalyst components.

The small amount of noncondensable gas formed in the process is vented from the vapor space of the

Butane Isomerization

PURPOSE.—Conversion of normal butane to isobutane.

The Shell process employs a catalyst in accomplishing the conversion of n-butane to isobutane. The reaction is carried out in the vapor phase in reactors containing granular aluminum chloride catalyst.

The catalyst was specially developed for the process and consists essentially of granular alumina impregnated with anhydrous aluminum chloride. It is rugged, cheaply produced, and long lived; these factors make it possible to discharge spent catalyst instead of regenerating it. Although the catalyst is resistant to poisons, it is necessary to remove most of the olefins and pentanes in the feed, as they destroy catalyst activity by forming tarry by-products.

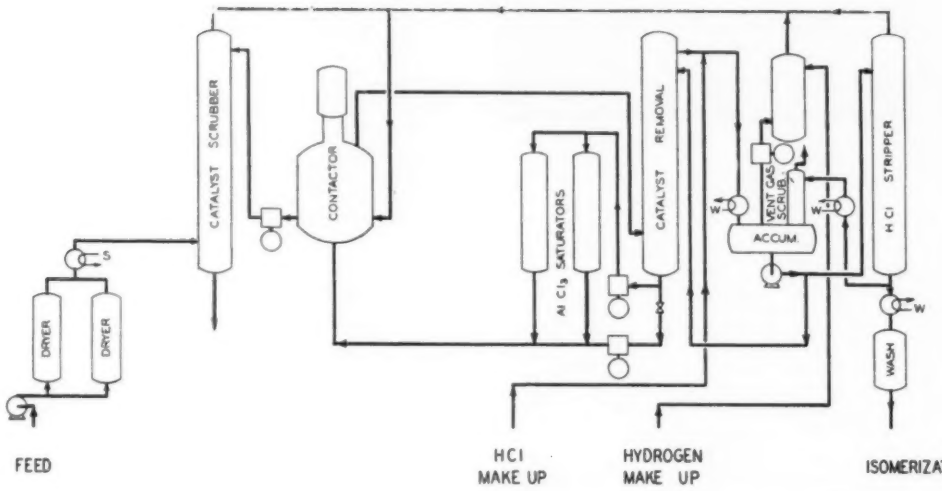
CHARGING STOCK.—A reactor for this process may have a single catalyst bed, or it may be of the heat-exchanger type. In the latter case, the catalyst is placed in tubes surrounded by circulating cooling liquid. Through one or more of these reactors is passed a mixture of normal butane and anhydrous hydrogen chloride, the latter acting as a catalyst promoter. As the isomerization reaction is reversible, the feed should contain as little isobutane as possible.

Following a single pass through the reactors, the stream flows through an absorber where volatilized aluminum chloride is removed. From here it goes through a cooler and a refrigerated condenser which liquefies all the butanes, the hydrogen chloride going into solution.

The small amount of gas that cannot be condensed is vented through an absorber where hydrogen chloride is recovered by scrubbing with product recycle. The condensate is then stripped of HCl.

EQUIPMENT.—In a typical isomerization plant the normal butane feed passes from the charging pump through a drier in which all traces of moisture are extracted. The circulating solution of strong, aqueous caustic soda commonly used for dehydration has the additional advantage of being able to remove harmful acidic components which may remain in the stream from prior processing. The feed is vaporized, divided, and run to the multiple reactor system, each stream receiving a controlled quantity of hydrogen chloride recycle gas.

After passing through the catalyst beds, the streams are combined and conducted through guard chambers filled with alumina which affects adsorption of the small quantity of $AlCl_3$ volatilized from the catalyst. The isomerizate then flows through a

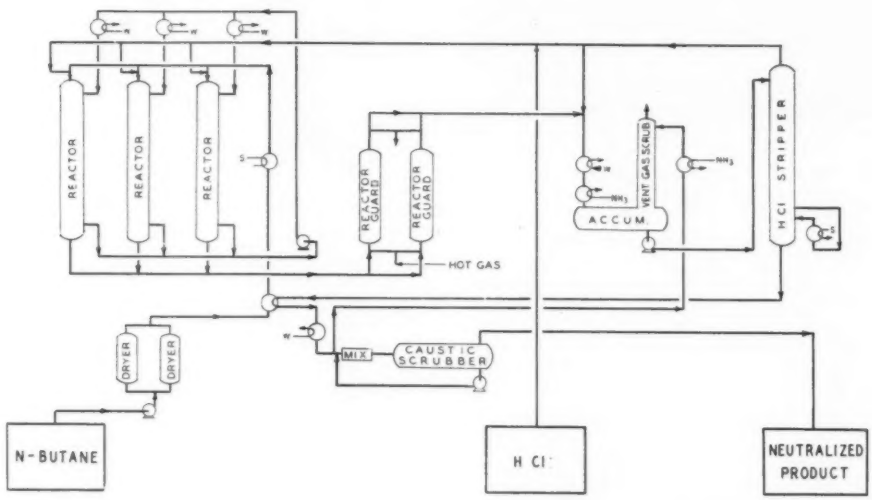


accumulator through a packed absorber. The HCl content of the vent gas is reduced to a minimum by a countercurrent wash with a cooled sidestream taken from the bottom product of the HCl stripper.

In pentane isomerization, most of the hydrogen is recycled from the vapor space in the accumulator; however, some remains in solution and passes to the HCl stripper from which it is recycled with the HCl.

From the catalyst column accumulator the isomerizate is pumped to the HCl stripper. The acid gas is removed from the top of the stripper and recycled to the contactor. The bottoms product stream is cooled and washed with dilute caustic to remove final traces of hydrogen chloride and antimony trichloride, and the neutralized isomerizate then passes to storage or subsequent operations.

Discussion on this process was supplied by its licensor, Shell Development Co., New York.



cooler and condenser into an accumulator, or receiver.

Liquid from the receiver is pumped to the top of a hydrogen chloride stripping column from which HCl is removed as the top product and recycled to the feed stream. The bottom product, consisting of butanes that are substantially free from HCl, is scrubbed with caustic to remove residual traces of hydrogen chloride and aluminum chloride.

No special construction materials are required for the plant as dry hydrogen chloride is not corrosive under the conditions generally prevailing in the process. In existing units, all major equipment is constructed of steel, with alloys used only in special applications such as trim on pumps and valves.

Discussion of this process was supplied by its licensor, Shell Development Co., New York.

Cycloversion Desulfurization

PURPOSE.—Lowers the sulfur content of gasolines.

The Perco catalytic desulfurization process employs bauxite as a catalyst which decomposes organic sulfur compounds contained in cracked, straightrun, and natural gasolines. This results in clear octane rating and TEL susceptibility increases, elimination or simplification of sweetening operations, decrease in corrosiveness, and increased stability of the gasoline.

Types of sulfur compounds removed include mercaptans, sulfides, and disulfides—the cyclic compounds are not greatly affected. The variation in quantity of cyclic compounds present in the abovementioned types of gasoline accounts for the differences in reduction of total sulfur content.

The catalyst can be regenerated an indefinite number of times without appreciable impairment of its activity. There is substantially no loss of hydrocarbons involved in the desulfurization treatment.

Basically, operations of this process result not only in "desulfurization" but also in a "catalytic" effect, producing improvement in octane and in TEL response not otherwise obtained merely by conventional methods for sulfur removal.

CRACKED GASOLINE
(56° A.P.I. gravity; 9-lb. R.v.p.; 420° F. e.p.)

	Undesulfurized	Desulfurized
A.S.T.M. octane number	65.7	69.1
1 cc. TEL	70.0	75.8
2 cc. TEL	72.4	78.0
3 cc. TEL	74.5	79.8
Total sulfur, per cent	0.140	0.076
Mercaptan sulfur, per cent	0.062	0.003

CRACKED-STRAIGHTRUN-POLY GASOLINE
(66.2° A.P.I. gravity; 9.9 R.v.p.; 355° F. e.p.)

	Undesulfurized	Desulfurized
A.S.T.M. octane number	58.6	63.9
1 cc. TEL	66.4	73.9
3 cc. TEL	73.1	79.0
Research octane number	61.4	67.2
1 cc. TEL	70.0	76.6
3 cc. TEL	77.9	83.7
Total sulfur, per cent	0.088	0.024
Mercaptan sulfur, per cent	0.023	Sweet

CHARGING STOCKS.—In general, 40 to 60 per cent of the sulfur contained in cracked gasolines are removed by the process. For straightrun gasolines in general, 60 to 98 per cent of the sulfur content is removed and for natural gasolines sulfur removal ranges from 90 to 100 per cent.

PRODUCTS AND YIELDS.—Typical examples of the effects of catalytic desulfurization on lead response are shown in the accompanying tables.

Shell Phosphate Desulfurization

PURPOSE.—To remove and recover hydrogen sulfide from refinery and natural gases and liquid hydrocarbon fractions.

The Shell phosphate process is particularly suitable for recovery of H_2S from which elemental sulfur may be made. For that purpose it is important that the recovered H_2S be of high prity, i.e., with minimum CO_2 and hydrocarbon content. The phosphate process can remove H_2S economically from gases containing CO_2 and H_2S in ratios as high as 20 to 1.

The process consists of two steps: absorption and regeneration.

The principal absorption reaction may be expressed by the equation:

$$K_3PO_4 + H_2S = K_2HPO_4 + KHS$$

Regeneration of the solution is effected by means of stripping steam, which reverses the absorption reaction. The optimum concentration of K_3PO_4 depends upon the amount and nature of impurities of the hydrocarbon processed.

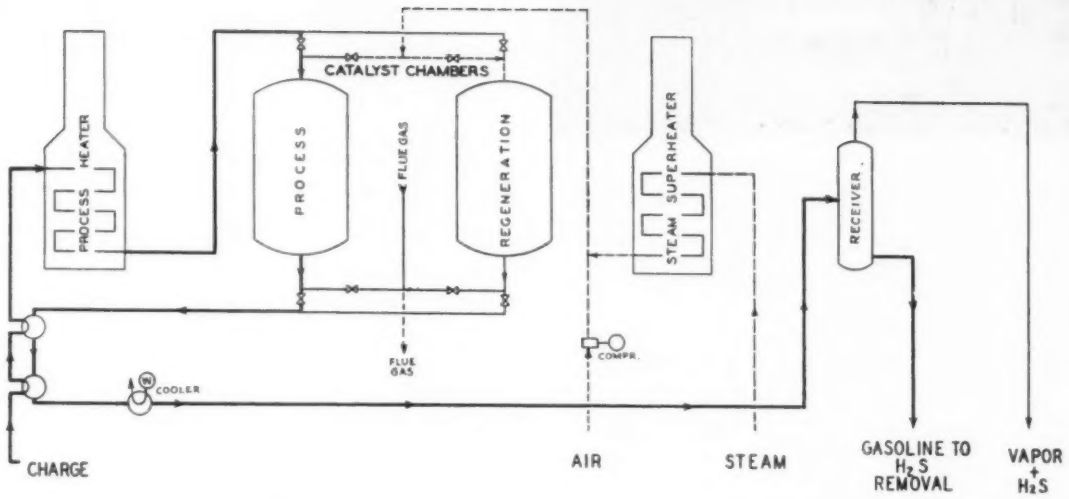
Treatment of gas and liquid streams differs only in the design of the extractor and, generally, in the use of split-solution flow for gas treating. The accompanying diagram shows the split-solution flew scheme.

The tripotassium phosphate solution removes H_2S selectively in the presence of CO_2. This unique feature of the process may be highly advantageous in desulfurization of natural or synthesis gases. In such cases it is often undesirable or unnecessary to remove all the CO_2 along with H_2S for reasons besides the higher attendant stripping steam consumption.

GAS CHARGE.—In treating gases, the extraction step is carried out in a bubble-tray column using split-solution flow. The raw gas is contacted countercurrently with the lean solution in the lower section of the column for removal of the bulk of H_2S; as it proceeds through the upper part of the column, it is further contacted with the very lean solution to achieve the final degree of H_2S removal required.

LIQUID CHARGE.—In the treatment of liquid hydrocarbon streams, the extraction step is achieved with countercurrent single-solution flow. After extraction, the liquid hydrocarbon flows through a solution coalescer which serves to safeguard against solution loss through entrainment in the extraction column overhead.

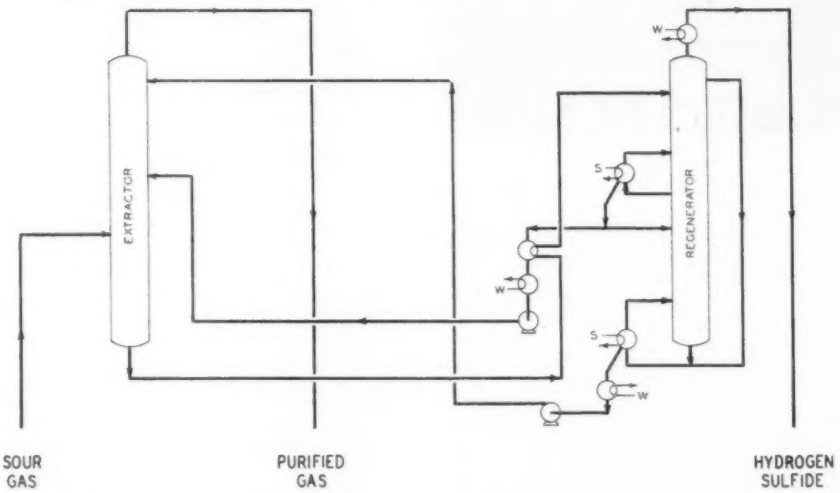
The hydrogen sulfide recovered from this process is essentially free of hydrocarbons and is an ideal raw material for manufacture of sulfuric acid or elemental sulfur. The optimum concentration of K_3PO_4 depends upon the amount and nature of impurities of the hydrocarbon processed.



Operating cycles up to 30 days or more for a charge of catalyst are obtained on many gasolines. Catalyst cost is in the order of 1 per cent per barrel of gasoline treated.

The treatment of cracked gasolines or blends containing cracked gasolines tends to deactivate the catalyst. Auxiliary equipment is provided for catalyst regeneration, which is accomplished by charging to the alternate chamber a stream of low-pressure air to burn off the carbonaceous matters. The air is admixed with a predetermined quantity of steam superheated to give a temperature of approximately 750° F. for the air-stream mixture entering the reactor on regeneration.

Discussion on this process was supplied by its licensor, Perco Division, Phillips Petroleum Co., Bartlesville, Okla.



EQUIPMENT.—Since K_3PO_4 is a stable inorganic salt which does not decompose nor vaporize under treating conditions, it does not contaminate nor polymerize the hydrocarbons and the solution loss is negligible. Iron and steel are satisfactory for all equipment. If the cooling water is corrosive, admiralty metal tubes and Muntz-metal sheets and baffles may be used for the condenser and solution coolers. Gages, instruments, valves, and pumps should be all iron and steel. Observance of these general specifications will insure freedom from corrosion on the process side.

Operating and maintenance costs are low. Full automatic control of the process is possible, so that only part of an operator's time is required for general supervision. Only occasional analyses are necessary to indicate proper operation.

Discussion on this process was supplied by its licensor, Shell Development Co., New York.

Unisol Process

PURPOSE.—To extract mercaptan compounds from gasoline and higher-boiling petroleum fractions, thereby accomplishing the purpose of conventional sweetening and at the same time improving tetraethyl lead susceptibility and other properties through removal of the sulfur associated with the mercaptan.

The Unisol process is based on the large increase in solubility of mercaptans in caustic soda solutions when an organic solvent, methyl alcohol, is present.

Hydrogen sulfide-free gasoline is introduced to the bottom of an extraction column and has mercaptans extracted from it as it flows upward in countercurrent contact with an aqueous solution of methanol and caustic soda. The caustic solution is introduced at the top of the extractor and methanol near the midpoint. Above the methanol inlet the caustic solution extracts any methanol dissolved by the gasoline from the caustic methanol solution.

A temperature recorder-controller in the middle section of the methanol column regulates stripping-steam flow. Water removal at the bottom of the column is regulated with a liquid-level controller.

Treated gasoline is removed from the top of the extractor and sent to storage without any subsequent treating except addition of inhibitor. The fat caustic methanol solution containing extracted mercaptans is removed from the bottom of the extraction column whence it is charged to a column in which the methanol and mercaptans are stripped from the caustic solution.

Regenerated caustic solution is recovered from the bottom of this column for reuse. From the top of the stripping column, steam-methanol-mercaptan vapors go to a condenser and then to a mercaptan separator from which the extracted mercaptans are decanted from the system. Aqueous methanol solution is charged from the mercaptan separator to a fractionating column from which methanol is recovered for reuse as an overhead product.

RESULTS.—Mercaptan reduction of better than 99 per cent is readily accomplished by the process. Octane-number improvements at the 3-cc. TEL level, range from one to three or more on the commercial units, depending on mercaptan sulfur content of the untreated gasoline. The treated product as it comes from the unit usually is sweet or nearly sweet. In almost all cases the product is completely sweet after a few days in storage, particularly if inhibited with U.O.P. No. 5 Inhibitor, which has the unique property of accelerating air sweetening.

In comparisons of the properties of Unisol-treated gasoline with the raw gasoline or with the product obtained by conventional sweetening, it generally is found that Unisol treating improves inhibitor susceptibility, lowers A.S.T.M. gum, and that copper-dish gums after inhibiting are considerably lower.

Mercapsol Process

PURPOSE.—Removal of mercaptans from gasoline.

The Mercapsol treating process accomplishes mercaptan removal by extraction with an aqueous solution of caustic soda fortified with certain solubility promoters. These solubility promoters act as hydrotropic salts and greatly increase the solubility of mercaptans in the aqueous phase. As a consequence, Mercapsol solution is a much more effective treating agent than plain caustic.

Superiority of Mercapsol over plain caustic is manifested in two ways. The first is that mercaptans which can be removed from gasoline by plain caustic are extracted more readily by Mercapsol. The second, and more important in treating applications, is that higher-molecular-weight mercaptans and branched-chain isomers occurring in the gasoline boiling range, which are practically unaffected by plain caustic, can be removed effectively by Mercapsol solution.

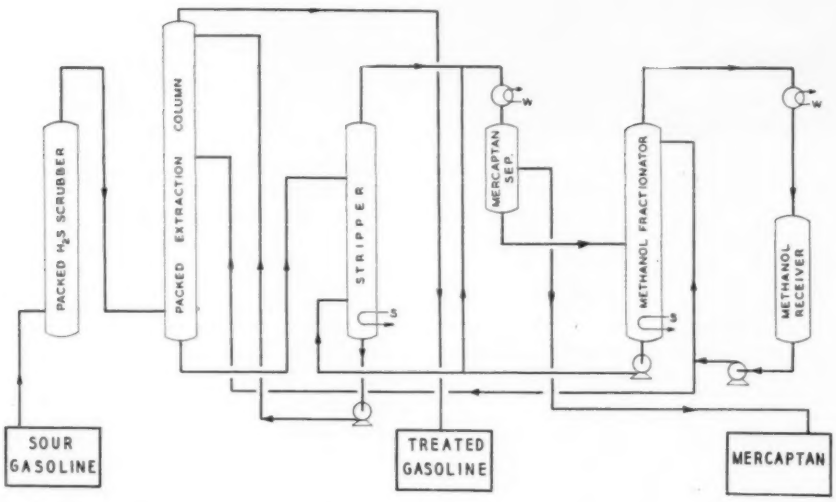
CHARGING STOCKS.—The process is effective in removing the mercaptans ordinarily occurring in any hydrocarbon liquid in the gasoline boiling range. However, it deserves particular consideration for the treatment of thermally cracked or thermally reformed gasolines of high mercaptan content where other treating processes which are suitable for other types of gasoline fail, for one reason or another, to perform satisfactorily on these stocks.

In the operation of the process, continuous countercurrent extraction is carried out in a packed or tray tower, multistage mixer-settler system, or other efficient liquid-liquid contacting device. Prior to mercaptan extraction, the gasoline is given a wash with low strength (5 to 10 per cent), caustic solution to remove H_2S, and in some cases certain other acidic substances, which occur in the gasoline.

A coalescer after the prewash step further protects the solution from contamination; a settler and a coalescer are used to clarify the gasoline from the mercaptan extractor. Spent Mercapsol solution is continuously regenerated by steam stripping in a packed or tray tower. Before the spent solution is regenerated, entrained and dissolved gasoline is removed and recovered by settling and stripping with a small amount of steam in an auxiliary stripper.

RESULTS.—Removal of 95 to 99 per cent of the mercaptan sulfur contained in most raw gasolines is practical with the use of this process. This removal results in a product of lower total sulfur content than would be obtained from a process which only converts mercaptans to disulfides.

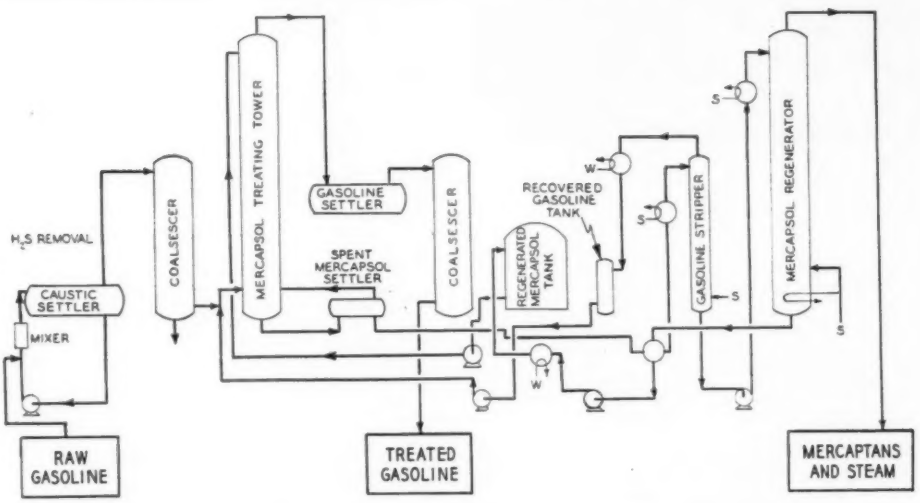
Ordinarily, the most important benefit derived from this lower sulfur content is the reduction in the amount of tetraethyl lead required to meet octane specifications. The process possesses a decided advantage in this respect over doctor treating.



Many gasolines contain more mercaptans than a conventional sweetening unit will successfully handle, making it necessary to remove part of the mercaptan by regenerative caustic extraction. In these cases a Unisol unit is said to cost no more to install than a combined caustic extraction plus sweetening units.

Recently developed modifications enable the process to remove 95 per cent or more of the mercaptans from distillates in the No. 2 fuel oil boiling range. Pyrrole-type nitrogen compounds are also removed by this process. Removal of these compounds by Unisol treating markedly reduces color and sediment forming tendencies in distillate oils as well as producing an oil of marketable odor.

Discussion on this process, a development of Atlantic Refining Co., was supplied by its licensor, Universal Oil Products Co.



Some gasolines can be extracted economically to the doctor-sweet specification with Mercapsol. In most cases, sweetening of the gasoline in storage after Mercapsol treatment can be accomplished by the addition of a suitable gum inhibitor.

MAJOR EQUIPMENT.—The process employs conventional-type equipment, and in many cases items of existing treating facilities are suitable for use in a Mercapsol unit. As the process is adaptable to practically any degree of automatic control the requirement for operating attention can be held to almost any desired level by appropriate instrumentation. Mercapsol solution is relatively inexpensive, and with proper precautions against contamination and loss, can be used indefinitely. The process is shown to operate at low cost.

Discussion on this process was supplied by its licensor, Pure Oil Co., Chicago.

Tannin Solutizer Process

PURPOSE.—Removal of mercaptans from sour gasoline.

The Shell tannin solutizer process is carried out in two steps—extraction and regeneration.

In the extraction step the sour gasoline is brought into intimate contact with strong caustic solution containing, besides a small amount of tannin, mercaptan-solubility promoters (solutizers) such as fatty acids, e.g., propionic and butyric acids, and/or alkyl phenols.

Tannin serves to catalyze the oxidation of the extracted mercaptans to disulfides in the regeneration step. These are removed from the solutizer solution prior to its recycle to the extraction operation.

In the extraction system the sour hydrocarbon feed is contacted with a suitable solutizer solution in countercurrent flow. The solution may contain as solutizer either added fatty acids or naturally occurring alkyl phenols.

Naturally occurring alkyl phenols may be used if their concentration in the fraction treated is great enough to maintain the required solutizer strength in the treating solution. For this purpose only a nominal concentration of alkyl phenols in the gasoline is needed; consequently most plants are self-sufficient and have very low solution costs. A typical system may use mixer-settler stages; however, other suitable contacting equipment such as towers have either Raschig ring packing or perforated trays have been used. The treated hydrocarbon flows from the extraction system to storage or subsequent operations.

The three essential steps of the process are caustic pretreat, solutizer treatment, and regeneration. Caustic pretreatment is often necessary to remove strongly acidic components, such as hydrogen sulfide, and in some cases to control the alkyl phenol concentration. A single conventional mixer-settler arrangement is usually satisfactory for this purpose, and the caustic solution may be used until it is essentially saturated. A coalescer follows the caustic settler to minimize contamination of the potassium hydroxide treating solution with sodium ion.

Treating solution from the extraction step is preheated and sent to the regenerator. The extracted mercaptans are catalytically oxidized to corresponding disulfides by air blowing in this column.

RESULTS.—By this process, mercaptan removal to the "odor sweet" level of 0.001 to 0.003 weight-per cent mercaptan sulfur is easily achieved when treating a wide range of straightrun or cracked stocks, either low-end-point or full-boiling-range gasolines. In many cases mercaptan content may be reduced to the doctor-negative specification (0.0004 weight per cent mercaptan sulfur).

Perco Copper Sweetening

PURPOSE.—Applicable to any stock requiring sweetening and is especially suitable for stocks of a very sour nature, these being handled with only a slightly higher cost due to increased air requirements. This method of sweetening is applied in two ways.

SOLID PROCESS.—If the stock to be treated is sufficiently stable in color and gum when treated in presence of air, it is mixed with the necessary air and percolated through a bed of absorbent material impregnated with the copper reagent.

SOLUTION PROCESS.—Other stocks are continuously treated with the copper solution in the absence of air and the copper regenerated in a separate tank. The oxidizing power of the solution is controlled to prevent side reactions with unstable hydrocarbon constituents. Stocks treated with the copper solution are given a final sodium sulfide wash to give color and gum stability, by removing minute traces of copper which may be present in the treated oil.

In either process, if the gasoline to be sweetened contains hydrogen sulfide, this component is removed by a caustic-washing step prior to the sweetening operations. Likewise, if free sulfur is present in the stock, this compound is removed by a caustic-polysulfide treatment prior to the sweetening operations. If hydrogen sulfide and free sulfur are not present, these steps may be omitted.

	Sour	Doctor treated	Perco treated
Color, Saybolt	+2	—5	+2
Octane number:			
Without lead	62.9	61.9	62.9
1 cc. TEL	68.5	67.8	68.5
2 cc. TEL	71.7	71.0	71.7
Induction period, minutes:			
Without inhibitor	130	130	180
With 0.002 per cent inhibitor	320	190	415
With 0.004 per cent inhibitor	485	305	640
A.S.T.M. gum	2.6	0.4	0.0

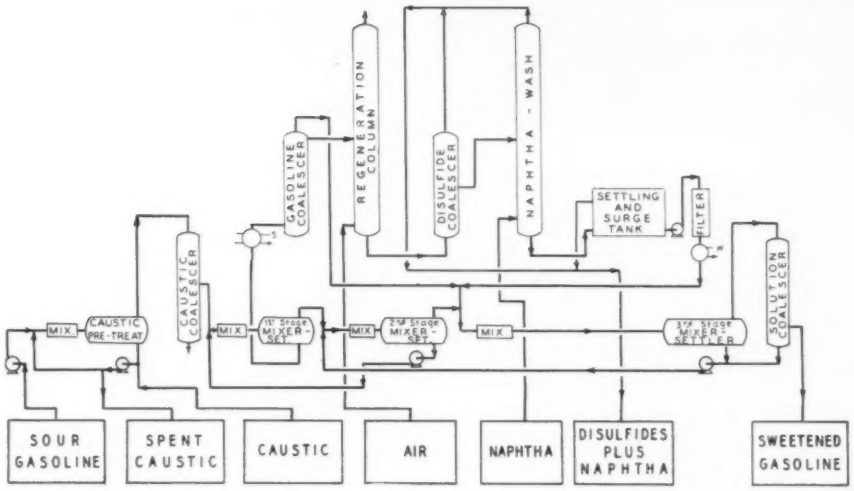
The process takes advantage of the oxidation of mercaptans by cupric chloride, and the subsequent regeneration of the cuprous chloride with oxygen (air) as shown by the equations:

$$\underset{\text{mercaptan}}{2RSH} + \underset{\text{cupric chloride}}{2CuCl_2} \longrightarrow \underset{\text{disulfide}}{RSSR} + \underset{\text{cuprous chloride}}{2CuCl} + \underset{\text{hydrochloric acid}}{2HCl} \quad (1)$$

$$2CuCl + 2HCl + \tfrac{1}{2}O_2 \longrightarrow 2CuCl_2 + H_2O \quad (2)$$

$$2RSH + \tfrac{1}{2}O_2 \longrightarrow RSSR + H_2O \quad (1) + (2)$$

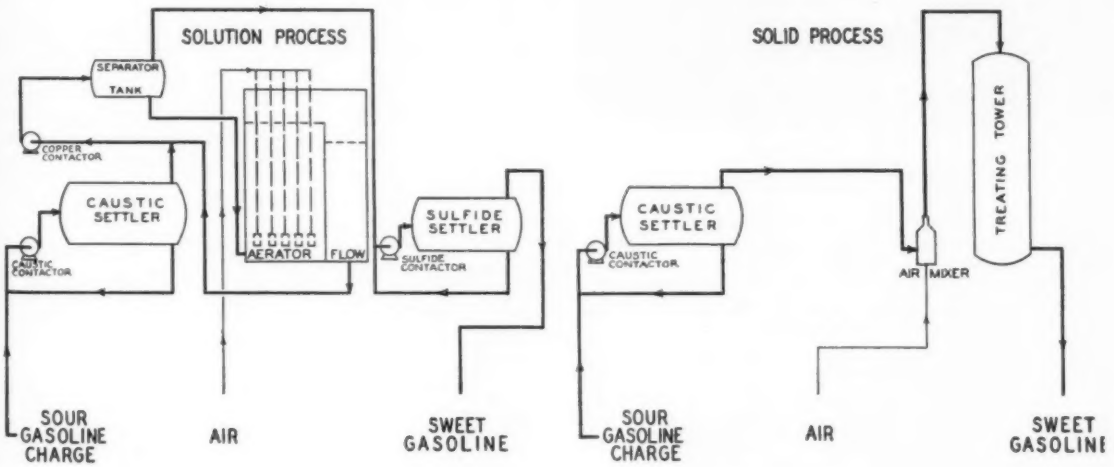
One of the features of the process is the theoretical absence of chemical consumption in the sweet-



EQUIPMENT.—A simple and flexible design, quite readily adaptable to utilization of existing equipment, characterizes this process. No corrosion-resistant metals are required as operating temperatures are low and the treating solution is noncorrosive.

OPERATING COSTS.—Labor costs are low due to simplicity of operation and adaptability to virtually complete automatic control. The solution is inexpensive and has an extended treating life, so that chemical cost is nominal. Exhaust steam can be used to fulfill the limited heating requirements.

This process is licensed by Shell Development Co. under its patents and those of Socony-Vacuum Oil Co., Inc. Discussion supplied by Shell Development Co., New York.



ening step. In practice it is necessary only to make up mechanical losses of the treating solution. Other operating charges are reduced, particularly labor costs, because of the simplicity of the method.

EQUIPMENT.—In the Perco solution process all equipment in contact with the copper solution is constructed of corrosion-resisting material, as the solution is corrosive to iron or steel. In the solid process ordinary materials are used throughout. Due to compactness of equipment and relatively small size for a given throughput, installation costs are low.

RESULTS.—The following example of liquid treatment of a cracked distillate having a 170° to 400° F. boiling range and 53° A.P.I. gravity is typical of results obtained in comparison to doctor treating.

Discussion on this process was supplied by its licensor, Perco Division, Phillips Petroleum Co., Bartlesville, Okla.

Benzene Manufacture

PURPOSE.—To recover benzene from hydrocarbon fractions.

In the Shell benzene-extraction process extraction distillation is employed. The extractive solvent is a relatively high-boiling liquid which has selective solvency for the aromatic and thus decreases its volatility relative to the nonaromatics. In the presence of such a solvent, the customary constant-boiling mixtures are absent, and nonaromatics normally boiling 25° F. above the aromatic can be distilled overhead.

The solvent usually employed in this process is phenol, but in special cases other solvents such as cresylic acids or sulfolanes may be preferable. The main steps in the process are:

1. Prefractionation.
2. Extractive distillation.
3. Acid treating and redistillation.

CHARGING STOCK. — The original charging stock is first fractionated to prepare a benzene concentrate. The prefraction columns have from 50 to 65 trays each. Since all low-boiling material can be separated from benzene during extractive distillation, the first fractionator serves primarily to lighten the load and improve extraction column operation.

Benzene concentrate is an overhead product from the second column.

RESULTS.—In commercial operation the recovery of benzene from suitable feed stocks is better than 90 per cent. The product has a purity of 98 to 99 per cent and is satisfactory for most uses; however, acid treating and redistillation may be necessary to meet nitration specifications.

EQUIPMENT.—The extractive distillation column consists of a knock-back section and an extraction section. Benzene concentrate is charged at a point near the middle of the extraction section, and supplied in a reboiler, and the condensed overhead vapors are partially returned as reflux.

The extractive distillation is normally carried out in a column of 65 trays, approximately 25 of which are in the knock-back section to prevent loss of solvent in the overhead raffinate. The top product contains essentially all the nonaromatics including the olefins and diolefins and only a trace of solvent.

Bottom product is a mixture of benzene and solvent and is separated in the solvent stripping column, which has 30 trays. Benzene is distilled off as top product, and the solvent is recycled to the extractive distillating column.

Loss of benzene in the raffinate from the extrac-

Ethylene Manufacture

PURPOSE.—Manufacture of ethylene from petroleum.

Crude petroleum and natural gas do not contain ethylene. However, the off-gas from refineries cracking petroleum stocks contain ethylene to considerable amounts, as much as 8 per cent at times. The supply from this source alone is usually inadequate and not economically recoverable.

CHARGING STOCK.—From the recovery and purification of ethylene from refinery off-gases are obtained gaseous and liquid petroleum fractions which are suitable for selective cracking to specifically produce ethylene. The ethylene-rich effluent combined with the refinery off-gases compose the total fresh charge to the ethylene recovery and purification section. Most ethylene-producing petroleum-chemical plants use either ethane, propane, or a mixture of ethane and propane as cracking charge.

The accompanying flow diagram illustrates a plant for the production of an ethylene-rich effluent from the cracking of ethane, propane, or an ethane-propane mixture. In this process the ethane-propane feed is charged to the cracking heater. Conversion to ethylene is accomplished at reaction temperatures between 1,460° and 1,510° F.

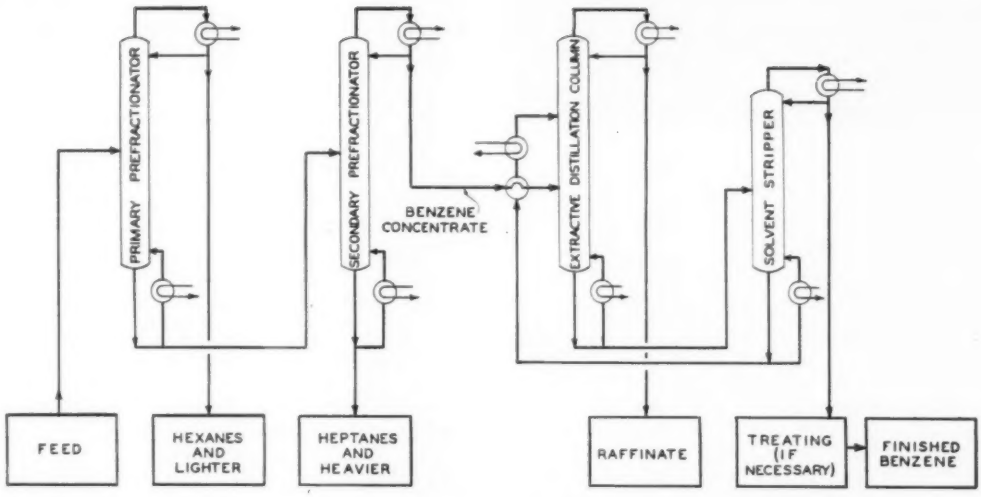
The heater effluent is shock quenched by a water spray and further cooled in the quench pots by the circulating water system. The effluent from the quench pots is further cooled in shell-and-tube exchangers and compressed. Compression is to a level consistent with the subsequent processing scheme. Polymers and heavy aromatic distillate are condensed and are decanted in the quench-water surge drum. Steam is generated from waste heat in the stack gas.

The cracking heaters for plants of this kind must be designed to give the high temperatures and low residence times required for the desired conversion without causing conditions leading to coke deposition in the tubes. Properly designed heaters result in on-stream periods consistently exceeding 100 days.

The recovery and purification of ethylene from refinery off-gas and cracking effluent may be carried out by chemical or physical means. For the production of alcohol, the separation is made chemically by treating the ethylene-rich gas directly with concentrated sulfuric gas. In this process the raw gas requires no pretreatment except the removal of hydrocarbons heavier than ethane.

PURIFICATION.—For the production of high-purity ethylene, as required by certain synthesis, several processes are used for purification. Lummus has contributed to the distillation processing scheme with the development of the fractionating absorber and has built several units of this type.

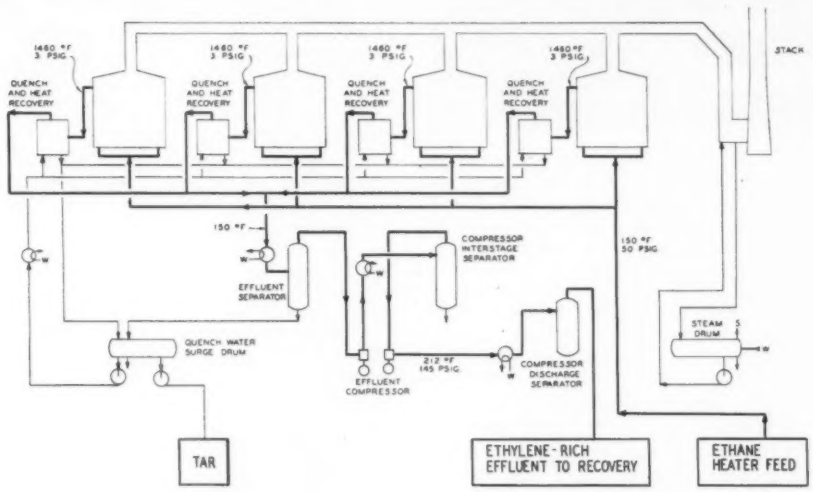
In this process the feed—refinery off-gas and ef-



tive distillation column is primarily a matter of control but need not exceed 1 per cent of the raffinate stream. Loss of solvent other than by mechanical leakage results from incomplete fractionation of solvent from the raffinate in the extractive distillation column and from the benzene product in the stripping column.

With appropriate design of the prefractionating columns the preferred feed stock may be any ordinary hydrocarbon mixture with sufficient benzene to give a concentrate containing about 10 per cent or more benzene. If the feed contains significant amounts of reactive materials such as mercaptans or diolefins, these must be removed from the feed or from the concentrate.

Discussion on this process was supplied by Shell Development Co., New York.



fluent from ethane-propane cracking—is water cooled and partially condensed by refrigeration before it is charged to the fractionating absorber where methane and hydrogen are rejected overhead while ethylene and the heavier hydrocarbons are absorbed in the lean oil. The stripper separates from the fat oil all hydrocarbons through C_4, leaving lean oil which is cooled and recirculated to the absorber. The stripper overhead is dried and further fractionated. Refrigeration for the unit is supplied by a system using propane as the refrigerant.

The separation in this process produces an off-gas consisting of the fixed gases, a high-purity ethylene product, ethane, L.P.G., and aromatic distillate and could be extended for the recovery of propylene if desired.

Discussion on this process was supplied by Lummus Co., New York.

Furfural Refining

PURPOSE.—Production of high-quality finished oils by selective solvent extraction of undesirable components from petroleum lubricating-oil stocks.

CHARGING STOCK.—The process may be applied to a wide variety of stock oils. Because of the high degree of selectivity and desirability of the physical properties of furfural, and because of the flexibility and economy of the process, it is widely used.

Furfural is produced largely from agricultural wastes and the supply is, therefore, limited only by the capacity of manufacturing equipment which can be expanded readily to meet the growing needs for furfural. Being nontoxic and noninjurious upon short contact with the skin, furfural can be handled without special protective provisions.

The boiling point of furfural is sufficiently low (323° F.) to permit its recovery from the lightest lubricating-oil stocks without loss of oil or critical loss of solvent. Its low solid point (—38° F.) eliminates the danger of solidification in lines or tanks in cold weather. The high specific gravity of furfural insures complete separation quickly in continuous extraction towers of relatively small diameter.

The critical solution temperature of furfural is high enough to permit its application to waxy or viscous oils at temperatures that insure treatment in the nonviscous, nonwaxy range.

Because of its stability over a wide range of operating conditions, furfural lends itself to a variety of methods of recovery from refined oil and extract solutions. Different types of solvent recovery systems have, therefore, been developed and used in order to provide the maximum of operating economy for each particular installation.

RESULTS.—Continuous improvement has been made over a period of years in the efficiency of the countercurrent extraction column. A higher degree of fractionation can now be obtained between the less-soluble, desirable fractions and the more-soluble, undesirable fractions. Untreated oil is introduced into the continuous countercurrent extractor at some midpoint and at a predetermined temperature ranging from 110° to 200° F.

Temperature of the furfural which enters near the top of the extractor varies depending largely upon the miscibility relationship between furfural and the particular oil being refined. A substantial temperature gradient is maintained between the top and bottom of the tower by indirect, external water coolers. The extraction generally is accomplished by passing the furfural in dispersed phase downward over raschig-ring nests through a prevailing oil phase. The raschig-ring nests afford an extensive surface of contact between the phases.

The concentration of undesirable constituents in

Furfural Extraction

PURPOSE.—Remove from diesel fuel oils, burning oils, and cracking stocks, materials having low cetane number as well as such undesirable materials as unstable, acidic, sulfur, organo-metallic, and nitrogen compounds, by solvent extraction.

The resultant treated oils show a marked degree of improvement in engine cleanliness, higher cetane number, improved burning qualities, and greatly reduced sulfur, nitrogen, and metals content. This process for the extraction of gas oils is an outgrowth of the furfural refining process which is widely used for refining lubricating oils but differs from the latter process in many details.

CHARGING STOCK.—Extraction temperatures and furfural treating ratios for gas oils are generally much lower than when refining lubricating oil stocks. The principal difference between these two processes, however, lies in the equipment for the recovery of furfural from the raffinate and extract fractions. Because of the low-boiling hydrocarbon fractions in gas oils, the furfural extraction operation employs water in the recovery of furfural, since any mixture of furfural and water containing 5 to 95 per cent of either component boils at about 208° to 210° F.

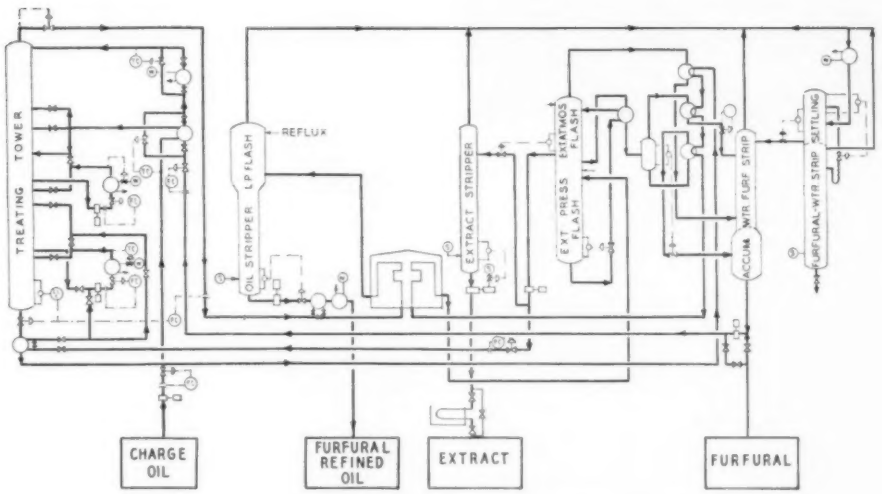
Following an azeotropic distillation, solvent-free raffinate and extract streams are taken from the base of the respective strippers while the overhead vapors from these columns comprising an azeotropic mixture of oil, water, and furfural are condensed and conducted to a decanter. Three liquid phases form in this decanting type of accumulator and all three of the components are present in each phase.

The heaviest phase is predominantly furfural which can be returned to the solvent circulating system because of the extremely low percentage of oil and water it contains.

The intermediate phase is predominantly water which is charged to the water-removal tower from the bottom of which a stream of solvent-free water flows to the plant drainage system while the overhead vapors are returned to the accumulator for redistribution among the three phases.

The lightest phase containing the oil is pumped to a countercurrent water-washing tower in which the furfural is extracted from the oil by water washing. The percentage of this light oil is dependent upon the initial boiling point of the gas-oil charging stock, varying from a negligible percentage for a stock with an initial boiling point of 500° F. or higher to about 3 per cent when processing a stock having an initial boiling point as low as 420° F.

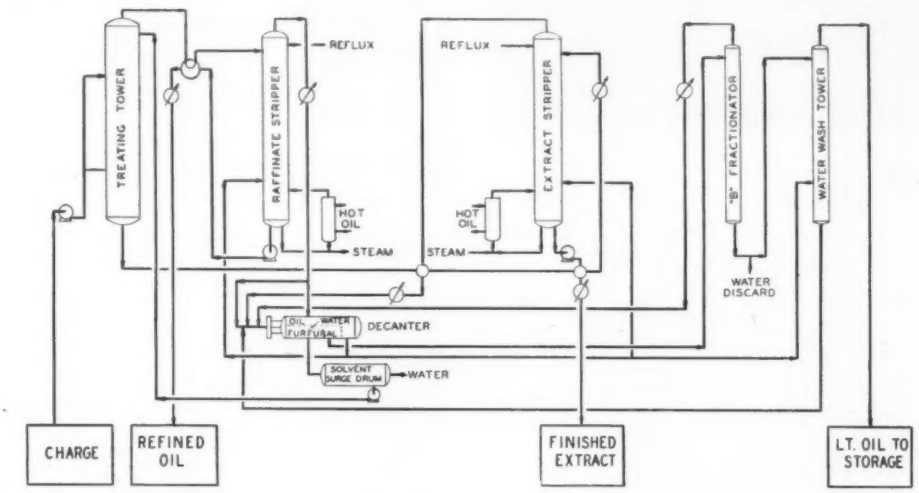
Fuel, bbl./bbl. of charge oil	0.0158
Steam at 250 psig., lb./bbl. of charge oil	43
Steam recovered as exhaust at 15 psig., lb./bbl. of charge oil	19
Net pounds of steam consumed, lb./bbl. of charge oil	24
Cooling water circulated, gal./bbl. of charge oil	250



the furfural phase increases toward the bottom of the tower from which the extract solution is continuously withdrawn. The quality of the oil in the oil phase improves as it progresses toward the top of the tower from which practically all oil of predetermined raffinate quality that is present in the charge stock, overflows with a small percentage of furfural dissolved in it.

Further improvement in extraction efficiency has been secured by the controlled recirculation of the material extracted. The recirculated extract serves to enrich the furfural phase with the more soluble material and thus to displace from solution the last remaining traces of "cycle oil," that can join the rising oil phase and eventually be refined to raffinate quality.

Discussion on this process was supplied by its licensor, Texaco Development Corp., New York.



The small percentage of oil and water in the recovered furfural does not have a significant effect upon the extraction efficiency of the treating tower.

RESULTS.—This process is characterized by low solvent requirements which range from 25 per cent of the charge oil when extracting a cycle gas-oil stock for recharging to a catalytic cracking unit to 40 per cent for a catalytic gas-oil stock extracted for the production of high-quality diesel fuel oil or furnace oils and to about 80 per cent when processing virgin gas-oil stocks for the production of fuels, burning oils, or cracking stocks.

The operating requirements when extracting a catalytic cycle stock with 40 per cent of furfural are shown in the accompanying table.

Discussion on this process was supplied by its licensor, Texaco Development Corp., New York.

Propane Deasphalting

PURPOSE.—Separating by liquid-to-liquid extraction, asphalt, color bodies, and other undesirable constituents from reduced crudes and fractionating the clean oil into portions of different viscosities.

Ability of the process to produce oil of excellent color and low carbon residue is completely independent of the asphalt content of the reduced crude. This, coupled with low operating cost, makes it possible to produce lubricating oils from reduced crudes previously considered unsuited for the purpose.

The process is also employed for fractionation of the deasphalted oil into two or more portions. By a simple variation of operating conditions, the highly viscous oil portions of reduced crudes may be separated into as many different fractions as is desired. Because all separations made with propane are carried out at relatively low temperatures, no cracking occurs.

CHARGING STOCK.—Stocks treated by this process are suitable for additional processing by single solvent extraction to produce high-quality lubricating-oil stocks. The process is frequently employed in combination with propane dewaxing and other single-solvent treatment for producing lube stocks from certain types of reduced crude oils.

PROCESS YIELD

Charge: °A.P.I. gravity 12.9—S.S.U. Vis. 210° F. 1249 Car. Res. per cent 13.9, Flash C.O.C. °F. 585—V.G.C. 0.890

	Deasphalted oil	Asphalt
Volume per cent yield	58.8	41.2
°A.P.I. gravity	21.7	1.0583 (S.G.)
S.S.U. vis. 210°	171.9	164 (M.P.)
Color—N.P.A.	6	.....
Car. res. per cent	1.81	.....
Flash C.O.C., °F.	580	.....
V.G.C.	.842	.....

Reduced crude is pumped through a steam heater into the upper portion of the deasphalting tower. Propane is pumped into the lower portion of the deasphalting tower from where it flows upward countercurrently to the descending asphalt phase.

Deasphalted oil is withdrawn overhead and flows to a low-pressure-steam propane evaporator, where a large amount of propane is flashed overhead through a condenser into the propane storage tank. The deasphalted oil-propane solution flows from the low-pressure-steam propane evaporator to the high-pressure-steam propane evaporator where the majority of the remaining propane is flashed off, joining the stream from the low-pressure-steam evaporator. The oil flows from the high-pressure-steam evaporator into a stripper, where the remaining propane is removed.

Propane vapor and stripping steam from the oil

Propane Dewaxing

PURPOSE.—Separating wax from crude oil in lubricating-oil manufacture.

The solvent, propane, is the only extraneous material used in the process since it serves both as a refrigerant and a solvent for the oil.

Economic features are low operating cost and wide adaptation to any type of lubricating stock. High yields of dewaxed oil of zero pour test or lower and wax of low oil content are obtained.

The low cost of propane, its double duty as a solvent and refrigerant, and its ease of recovery are features which make for high efficiency.

CHARGE STOCKS.—Various waxy oils may be successfully and economically dewaxed by this process. Typical of some stocks being treated by propane dewaxing are those from Mid-Continent and East Texas crude oils. With prior treatment by propane deasphalting and phenol extraction, heavy distillates and other lubricating-oil stocks from these crude oils respond readily to propane dewaxing.

Propane dewaxing is often employed in combination with propane deasphalting and acid treatment in propane solution.

Oil and propane are charged continuously under

PROCESS YIELD

Charge: °A.P.I. Gravity 25.8—S.S.U. Vis. 210° F. 140.9—Car. Res. per cent 0.86—V.G.C. 0.814.
Volume per cent propane 300
Filtering temperature, °F., —43

	Dewaxed oil	Wax
Volume per cent yield	84.2	15.8
°A.P.I. gravity	24.6	150 (M.P.)
S.S.U. vis. 210° F.	156.7	.....
S.S.U. vis. 100°	2,735	.....
Color N.P.A.	6—	.....
Car. Res., per cent	1.09	
Solid pt., °F.	—6	
V.I.	94.0	
V.G.C.	.822	

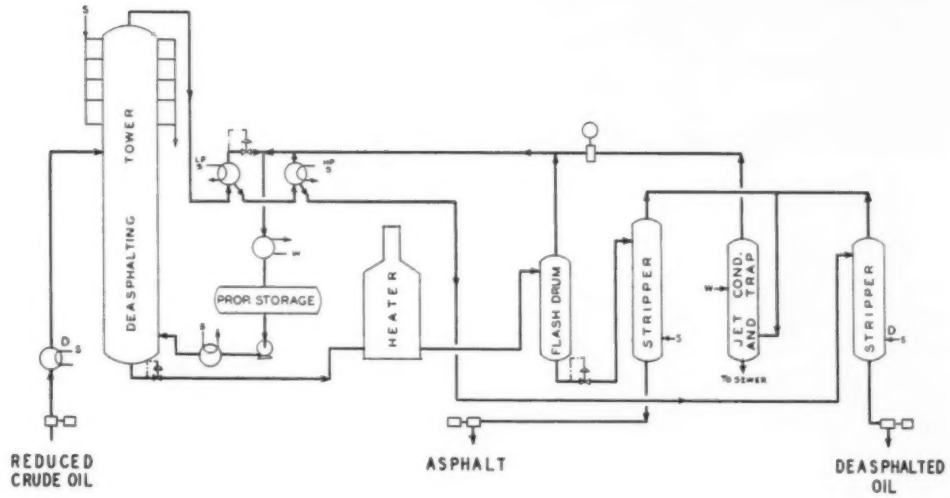
flow control, warmed to dissolve all the wax, and sent to a chilling vessel in which reduction of temperature to approximately —40° F. is effected by allowing propane to vaporize directly from the solution.

Wax crystallizes out at this low temperature and is separated from the oil on a continuous rotary pressure filter of most modern design.

The filter cake is washed with cold liquid propane to remove oil adhering to the wax crystals and then transferred by means of a screw conveyor and wax pump to propane-recovery equipment.

The dewaxed filtrate also is sent to a propane-recovery unit. Both end products—dewaxed oil and wax—are pumped from the strippers to storage tanks. Over-all loss of the propane solvent is low and control methods for the process are relatively simple.

Two compressors are employed in the low-tem-



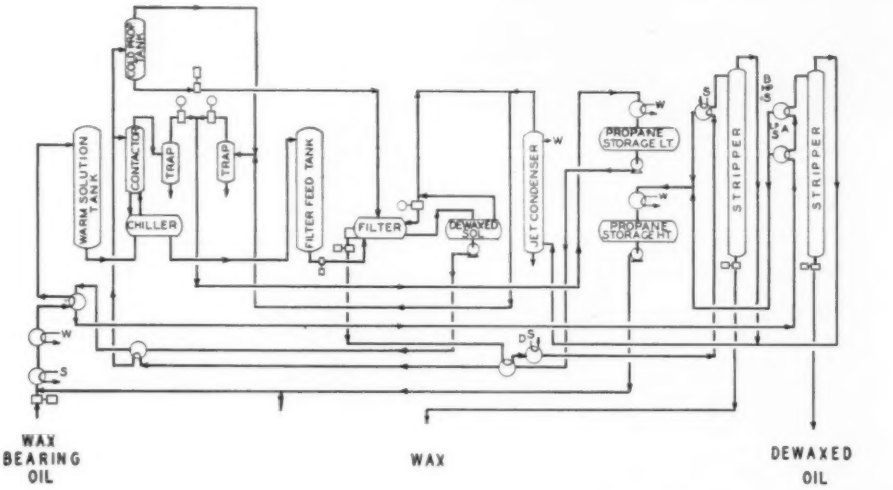
strippers are taken to a jet condenser and trap where the steam is condensed. Vapor from the condenser is picked up by a compressor, condensed, and delivered to a propane-storage tank.

The asphalt solution is withdrawn from the bottom of the deasphalting tower and passes through a furnace and thence to a flash drum where the greater part of the propane is flashed overhead, joining the combined propane streams from the low-pressure and high-pressure-steam evaporators.

The asphalt with remaining small percentage of propane is withdrawn from the bottom of the flash drum into a steam stripper, where the remaining propane is removed.

RESULTS.—Yields when processing 22.8 per cent Van Zandt reduced crude oil are shown in the accompanying table.

Discussion on this process was supplied by M. W. Kellogg Co., New York, licensing agent.



perature propane circuit of the process. The high-temperature circuit connects into the unit's propane evaporators. Propane vapors from the evaporators are condensed and delivered into high-temperature storage from which the solvent liquid is pumped into the wax-bearing oil charge stream. The two strippers are connected to a jet condenser which in turn is connected into the low-temperature propane circuit via the suction side of one of the compressors.

Intake of the second of the two compressors is connected only into contactor via a trap.

RESULTS.—The accompanying table shows yields when charging deasphalted, phenol-treated, 22.8 per cent Van Zandt crude for processing to aviation lubes.

This discussion was supplied by M. W. Kellogg Co., New York, licensing agent for the process.

Phenol Treating

PURPOSE.—Improving viscosity index and oxidation resistance, and for reducing carbon and sludge-forming tendencies for lubricating oils.

CHARGING STOCK.—This liquid-liquid extraction process has been used successfully for many years either before or after dewaxing on both distillate and residual oils from all types of crudes, but is probably most successfully used in conjunction with propane deasphalting.

Used in conjunction with propane deasphalting, the process removes naphthenic acids thoroughly and handles stocks of high sulfur content satisfactorily without loss of solvent as the result of chemical reaction.

Phenol gives high yields of desired products and has exceptional stability. The solvent is continuously reused, with low losses (0.01 per cent of the total solvent circulated per day in well-operated plants). The high solvent power of phenol necessitates only comparatively low ratios of solvent to oil.

Raw stock and dry phenol are fed into the treating tower. Prior to entering the treating tower, the feed stock flows through the phenol absorber tower to remove the remaining phenol from process water being discharged from the plant.

PROCESS YIELD

Charge: A.P.I.° Gravity 21.7—S.S.U. Vis. 210° F. 171.9—Car. **Residue** per cent 1.81—Flash C.O.C. 580° F.—V.G.C. 0.842. **Volume** per cent Phenol 204.

	Raffinate	Extract
Volume per cent	79.2	20.8
°A.P.I. gravity	25.8	7.8
S.S.U. Vis. 210° F.	140.9	
Color—N.P.A.	5	
Car. Res. per cent	.86	
V.G.C.	.814	

Raffinate phase is withdrawn from the top of the treating tower to the raffinate storage drum from which it is fed through a heat exchanger, exchanging heat with the treated raffinate oil, thence through a coil in the raffinate furnace and is flashed into the evaporator section of the raffinate tower at substantially atmospheric pressure. Phenol vapor recovered in this section flows to the phenol condenser and enters the phenol storage tank.

The extract phase is withdrawn from the bottom of the treating tower, fed through heat exchangers, and enters the drying section of the phenol tower in which all water is removed as constant-boiling phenolic water vapor. The phenolic water vapor leaving the top of this section is condensed and enters the phenolic water drum from which is drawn reflux for the drying section, as well as the water required for modification of solvent at the bottom of the treating tower.

Dry extract solution is pumped from the bottom

Duo-Sol Extraction

PURPOSE.—Separation of desirable and undesirable compounds in charge stocks in the manufacture of lubricants.

Duo-Sol extraction is a process for the manufacture of lubricants in which two solvents are used countercurrently. The process employs as one solvent, propane, which has a high solubility for the raffinate and, as a second solvent, selecto, a blend of cresol and phenol which has a high affinity for the extract or undesirable components such as: asphalt, asphaltines, unsaturates, and color bodies.

The solvents themselves have only limited solubility for each other and, therefore, whenever mixed with oil in proper proportions form into a heavy extract phase containing selecto, extract, and little propane, and a light raffinate phase containing propane, raffinate, and little selecto. These phases are ordinarily separated by gravity.

CHARGING STOCK.—The process is unique among solvent processes in its ability to handle residual charge stock without first removing the asphalt from the oil portion and, therefore, for operations which employ residual charge stocks for the manufacture of lubricants.

Whether operating on neutrals, residual charge for bright stock, or long residual stock which is later rerun, the Duo-Sol process inherently produces fine-colored oils with very low carbon residue and excellent stability, thereby greatly decreasing clay requirements for finishing oils.

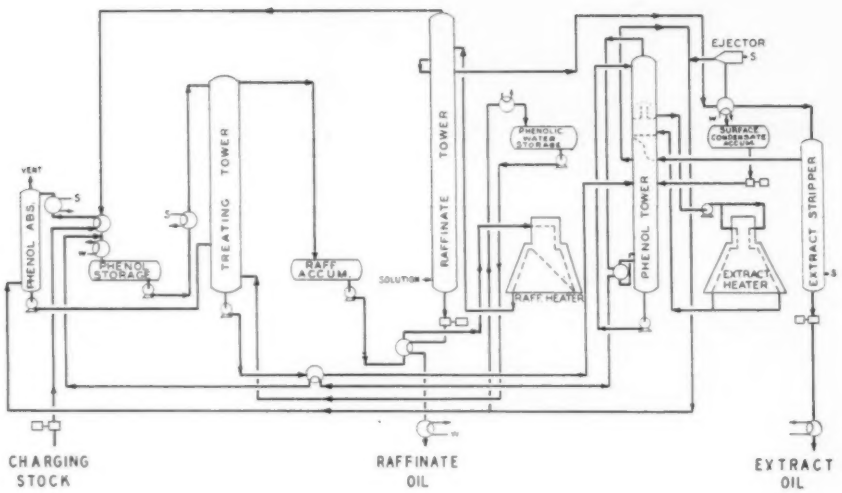
EQUIPMENT.—The extraction system consists of seven extractor vessels. In each of these extractors the charge of solvents and oil is mixed and then settled in a raffinate and extract phase which leave the vessel from the top and bottom respectively.

Fresh propane is charged into the first extraction vessel together with the extract from the second extraction vessel. The final extract phase leaving the system is discharged from the first extractor while the raffinate layer from the first extractor passes on to the second extractor.

Fresh selecto is charged to the seventh extractor together with raffinate from the sixth extractor. The final raffinate phase from the seventh extractor leaves the extraction system while the extract from the seventh extractor is pumped to the sixth.

Charge stock is introduced into the third extractor where an initial separation of raffinate and extract occurs. This extract passes countercurrent to the propane through extractors 2 and 1, stripping the extract of any desirable components. The raffinate from the third extractor passes through extractors 4, 5, 6, and 7 and is successfully treated with greater and greater concentration of selecto which removes all undesirable materials in the raffinate.

SOLVENT RECOVERY.—The system for solvent

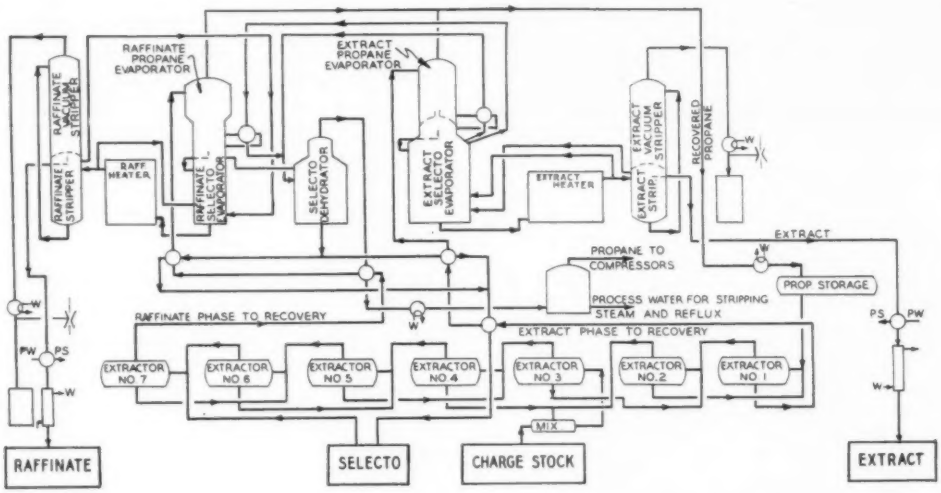


of the drying section of the phenol tower to the top of the evaporator section of the phenol tower where a portion of the solvent is flashed off. Phenol vapor recovered in this section flows through exchangers into the phenol storage drum. The remaining extract drops to a pan in the evaporator section of the phenol tower and is pumped through a coil in the extract furnace returning to a point below the pan in the evaporator section of the phenol tower.

The last traces of dissolved phenol contained in the extract oil from the evaporator section are removed in the extract stripper. Stripped extract is delivered to storage.

RESULTS.—The accompanying table shows yield results when processing deasphalted 22.8 per cent Van Zandt crude for aviation lubes.

Discussion on this process was supplied by M. W. Kellogg Co., licensing agent.



recovery is so designed that heat is supplied only for the evaporation of selecto while the selecto vapors and liquid supply all heat required for evaporation of propane and the outgoing products supply the heat necessary for the generation of all process steam. Thus, fuel is required only for the recovery of the one solvent, selecto.

The process is not limited to treatment of residual stocks. It is extensively used where distillates and residual stocks are alternately treated. Single units in commercial operation have run as many as six or eight different stocks varying from naphthalenic distillates to mixed-base residua, within the period of a month.

Discussion on this process was supplied by its licensor, Max B. Miller & Co., New York.

Wax Manufacturing

PURPOSE.—Production of oil-free wax.

The process generally employs a mixture of the same solvents (ketones and aromatic solvents) as those used in the solvent dewaxing process. In fact, the two processes can be operated concurrently in a single plant using the same solvent supply.

The wax-manufacturing process is characterized by an operating technique involving crystallization of wax or a selected portion of the wax contained in the petroleum oil or waxy concentrate by first cooling in the absence or substantial absence of solvent, then adding solvent in small increments until all of the desired wax types have crystallized. Sufficient cooled solvent is then added to the cooled waxy slurry to permit separation of the solid wax from the liquid phase by filtration.

Crystalline and microcrystalline waxes with melting points ranging from below 120° to above 170° F., depending upon the nature of the charge stock, can be produced.

COMBINATION OPERATION.—In the combined operation of the solvent dewaxing and wax manufacturing process low-pour-point dewaxed oil and oil-free wax are produced concurrently.

Operation is continuous and highly economical in the use of solvent whether producing regular grades of white crystalline wax and dewaxed neutral oils or high-melting-point, microcrystalline wax from distillate or residual oils.

Use of a closed flue gas system minimizes fire hazards and solvent losses.

The wax-bearing stock is chilled in scraped-surface chilling equipment without dilution solvent. After the wax has started crystallizing, about 0.10 parts of solvent (methyl ethyl ketone-benzene-toluene) per volume charge oil is added. As more wax crystallizes, small portions of solvent are added as necessary to maintain a workable pressure drop through the cooling equipment. When the temperature required for production of 0° F. pour point dewaxed oil is reached, a final amount of solvent is added to bring the mixture to proper filtering viscosity.

Repulped slurry is continuously filtered on a second filter and the final product wax is again washed. Cake from this filter is pumped to the solvent-recovery system from which the solvent-free and oil-free product wax is delivered to storage and the solvent to supply tanks.

Filtrate from the secondary filter, containing a small amount of oil and undesirable soluble wax fractions, is pumped to the solvent-recovery equipment from which the "soft" wax is delivered to storage and the solvent returned to the system.

SOLVENT-OIL RATIO.—Over-all solvent dosages for both the dewaxing and wax-manufacturing operation vary from a solvent-to-oil ratio of approxi-

Wax Fractionation

PURPOSE.—Production of wax of low oil content.

This process generally employs a mixture of the same solvents (ketones and aromatic solvents) as those used in the solvent dewaxing process. The two processes can be operated independently and concurrently in a single plant, using the same solvent supply, and charging the wax cake, comprising wax and solvent from the dewaxing operation directly to the wax fractionation operation without first recovering the solvent from the wax.

The wax fractionation process employs an operating technique involving the crystallization of wax or a selected portion of the wax contained in a waxy concentrate in the presence of a substantial amount of solvent. Thus a substantial amount of solvent is added to the charge stock before any of the wax is crystallized. More solvent may be added later or all of the solvent required for dilution purposes may be added before any of the desirable wax has been crystallized by cooling. The solid wax is separated from the liquid phase by filtration at a temperature suitable for the desired degree of fractionation.

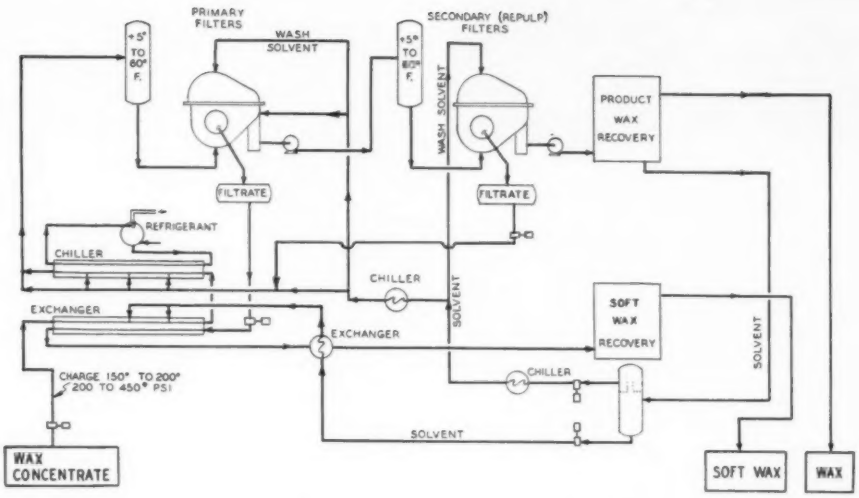
COMBINED OPERATION.—Typical of the combined operation of the solvent dewaxing and wax fractionation process is a case in which low-pour-point dewaxed oil and wax of low oil content are produced concurrently. In the operation, a mixture of the wax-bearing charge stock with a substantial amount of solvent is chilled in double-pipe, scrapped surface chiller equipment to a temperature suitable for the production of dewaxed oil of the desired pour point. The mixture is then filtered and oil-bearing solution in the wax cake is washed continuously from the wax by displacement with cold solvent.

Wax cake without the removal of solvent is continuously discharged from the primary filters and heated until the wax is totally dissolved in the solvent. Additional warm solvent is blended with the wax-cake solution and the mixture cooled in double-pipe, scrapped surface equipment to a predetermined temperature necessary to crystallize the desired wax fractions and obtain the proper quality of wax. The recrystallized wax is then continuously separated by means of a second filter on which the product wax receives a final wash.

Operation is simple and continuous whether producing regular grades of white crystalline wax from neutral oils or high-melting point, microcrystalline wax from high-viscosity distillate or residual oils.

SOLVENT-OIL RATIO.—Over-all solvent dosages for a combined dewaxing and wax fractionation operation vary from a solvent-to-oil ratio of approximately 3.5:1 for low-viscosity lubricating-oil distillate stocks to 9.0:1 for viscous residual stocks.

The wax fractionation process is also used inde-

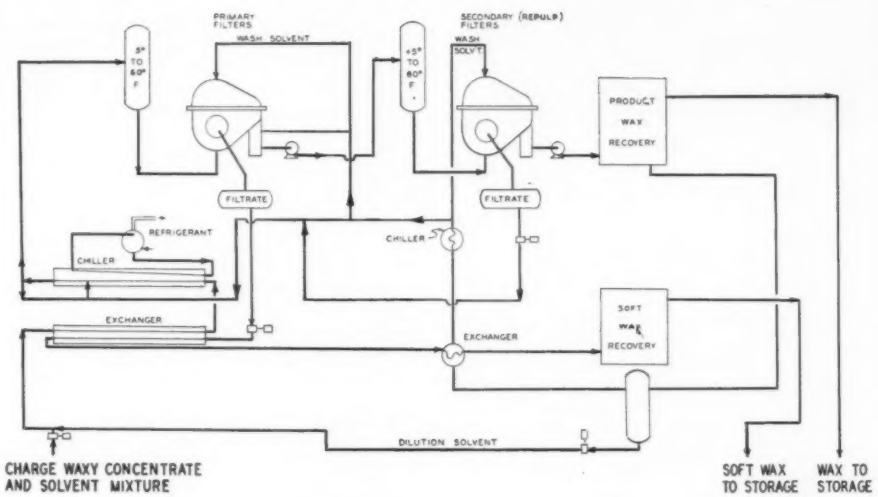


mately 2.5:1 for low-viscosity distillates to 7.0:1 for viscous residual stocks containing microcrystalline waxes.

The process yields waxes of very high quality and of precise fractions not normally obtained by other methods. Crystalline waxes produced consistently show oil contents by A.S.T.M. analysis that are below 0.3 per cent and with certain types of crystalline waxes below 0.1 per cent.

Oil in the wax cake is washed continuously from the wax by displacement with cold solvent. The total wax cake is continuously removed from the filter and additional solvent mixed or repulped with the wax slurry at a temperature necessary to retain any remaining oil and low melt point, undesirable wax fractions in solution.

The process is the development of Texaco Development Corp. and Union Oil Co. of California. Discussion was supplied by its licensor, Texaco Development Corp., New York.



pendently of solvent dewaxing to produce high-quality waxes from wax concentrates produced in an independently operated dewaxing unit or from naturally occurring wax concentrates or tank bottoms.

The process is capable of producing crystalline waxes which consistently show oil contents by A.S.T.M. analysis that are below 0.5 per cent. The quality of microcrystalline waxes is frequently judged upon the basis of melting point and penetration. Depending upon the source of the raw waxy concentrate, finished microcrystalline waxes can be produced which, without additives of any kind, have melting points as high as 200° F. and asphalt penetrations at 77° F. as low as 1.0.

The process is licensed by Texaco Development Corp., New York.

Solvent Dewaxing

PURPOSE. — Produce wax-free lubricating-oil stocks.

This dewaxing process generally employs a mixture of methyl-ethyl-ketone and an aromatic solvent (benzene, toluene, or a mixture of the two) as the solvent to obtain a dewaxed-oil pour point equal to or within a few degrees of the dewaxing temperature. The dewaxed oils are free from wax cloud and there is no rise in pour point or "pour reversion" on aging. Either distillate or residual stocks in the raw state or refined, of any viscosity, can be dewaxed.

Simplicity of operation, flexibility, low construction and operation costs, the absence of special equipment, special alloys, high pressure, excessively low operating temperatures, and the ability to obtain high dewaxed-oil yields and very low-oil-content waxes are outstanding characteristics of the process.

SOLVENT-OIL RATIO.—The wax contained in lubricating-oil stocks when properly crystallized from a chilled solution in the solvent mixture is particularly adaptable to removal by filtration. Practically complete separation of oil from wax is obtained by use of a cold displacement wash. Use of a closed flue-gas system minimizes fire hazards and solvent losses. Dilution solvent dosages vary from a solvent-to-oil ratio of 1.0:1 to as much as 4:1, depending upon the nature and viscosity of the charge stock.

Proper conditioning of the charge to the filters by controlled application of solvent has increased dewaxed-oil yield, reduced oil content of the wax, and reduced the amount of solvent circulated per barrel of oil charged.

An additional development has been the production of wax, without addition agents, concurrently with the production of low-pour-point oil, but in auxiliary equipment operated as a separate process.

CHARGE STOCK.—White crystalline waxes and higher-melting-point microcrystalline waxes are produced from distillate and residual stocks, respectively, to meet specific requirements.

Dilution solvent is introduced into the charge-oil stream in such amounts, at selected points in the chilling cycle, as to insure a wax crystal structure and liquid viscosity most suitable for filtration. The chilled charge mixture flows from the double pipe chillers through a filter feed tank to drum-type vacuum filters in which compartmentized, cloth-covered drums rotate half submerged in enclosed filter cases.

The wax cake deposited upon the drum during filtration is washed with cold solvent as it emerges from the liquid level in the filter. Just before each of the filter drum compartments reaches the wax deflector, flue gas at low pressure is admitted through a blowback connection to the underneath

Edeleanu Process

PURPOSE.—The Edeleanu process is employed in the refining of naphtha, kerosine, gas oil, and light lubricating oils. It is equally suitable for treatment of medium and heavy lubricating oils, but for that purpose it must be used under temperature and pressure conditions which make its application less attractive from a practical standpoint. The process is a selective extraction one, employing liquid sulfur dioxide as the solvent.

Sulfur dioxide exhibits its highest selectivity at subatmospheric temperatures. The optimum extraction temperature varies with the boiling range of the oil treated and with the desired degree of separation. For maximum concentration of aromatics in the extract, the treating temperature should be fixed as low as is economically feasible.

Quality of the raffinates will increase with solvent ratio while that of the extract, as expressed in terms of aromatic concentration, will increase with decreasing temperature maintained in the extract phase.

In commercial use since 1911, initial application of the process was in the production of high-quality kerosines from sulfur-bearing and highly aromatic stocks. Superiority over certain acid-treating methods subsequently led to application of the process to a broad range of stocks.

CHARGING STOCKS.—For treatment of naphthas, solvent ratios of 50 to 100 volume per cent are commonly applied. The raffinates obtained will have a low sulfur content and a high aniline point, while extracts are of high solvency (Kauri butanol numbers of 65 to 70).

The kerosine treatment will take 50 to 100 volume percent of solvent for lamp oil, and up to 150 per cent for high-quality specialties. A treatment with 100 per cent SO_2 at 150° F. will raise the smoke point by 10 to 15 points and will reduce the sulfur content to about 20 per cent of the original.

Treatment of gas oils for the production of high-speed diesel fuel will usually take not over 100 volume per cent of solvent. Consistent with their high paraffinity the raffinates will have a high cetane value and aniline point. The effect of the treatment on the sulfur content is similar to that obtained in kerosine treatment.

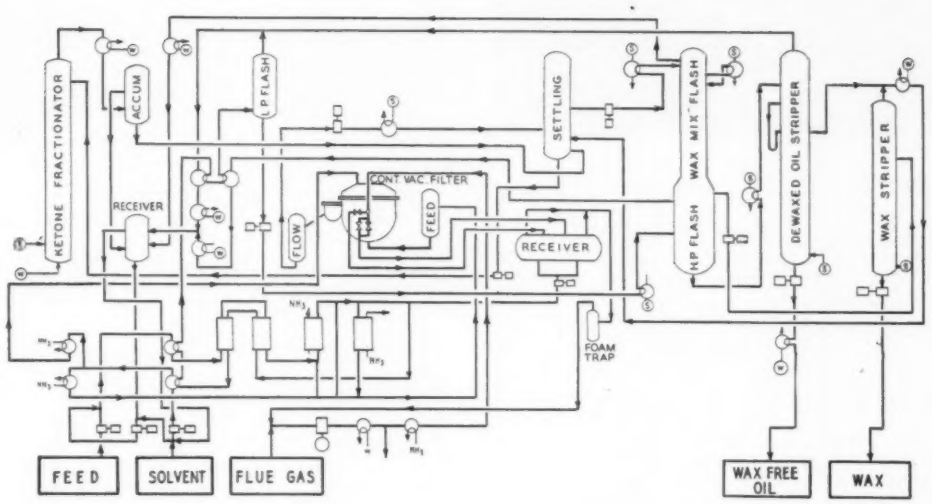
SOLVENT RECOVERY.—In recovery of solvent from the raffinate and extract, three stages of evaporation are commonly employed:

1. First stage connected to water-cooled condensers and operating at 50 to 80 psig.

2. Atmospheric stage served by the compressors.

3. Final stripping stage operating under vacuum. Temperature levels are moderate, so that live and exhaust steam are the only source of heat required.

With treating ratios in excess of 50-60 per cent, a double-effect evaporation may be used in the extract-recovery system, with a preflash stage usually held



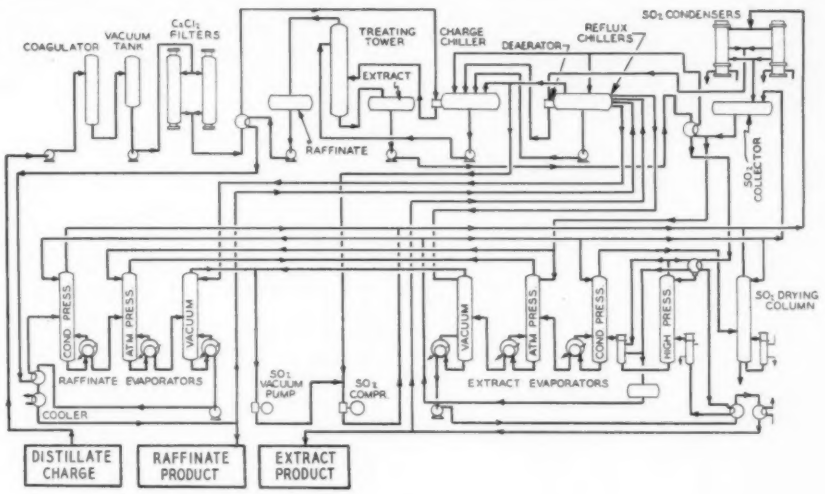
side of the filter cloth. The bond between wax and cloth is broken and the washed wax falls into the wax discharge compartment.

Filtrate from the main filtrate receiver is pumped through double pipe exchangers to evaporators for recovery of the solvent. Heat for evaporating the solvent from the dewaxed oil solution and wax mix may be supplied by either steam or fired heaters.

Substantially all of the water entering the system is crystallized and removed with the wax to the wax-mix surge tank where it is separated from the mix and the water subsequently removed from the system.

Consistent uniformity in operating conditions and product quality is an inherent characteristic of the process. There are no corrosion or erosion problems and low-pressure equipment is used throughout.

The process is licensed by Texaco Development Corp., New York.



at 200 psig. and the vapor from this stage condensed by heat exchange with the flash residue. In plants designed for treatment of naphthas only, the vacuum evaporators are omitted.

All solvent recovered from the products is ultimately liquefied and returned to the system.

For the production of highly aromatic extracts (from any stock dealt with herein) some refiners have employed extract phase temperatures down to minus 60° F. In one unit SO_2 has been used in conjunction with an aliphatic stripping agent to produce nitration-grade toluene from hydroformed naphthas.

In spite of the potentially corrosive nature of the solvents, Edeleanu plants have long life and require little maintenance. The yearly turnaround of these plants usually takes no more than 4 to 5 days.

Discussion of this process supplied by E. B. Badger & Sons Co., Boston.

Girbotol Process

PURPOSE.—For purifying refinery and natural gases and hydrocarbon liquids and separation of carbon dioxide from synthesis gas mixtures.

This continuous cyclic process separates acidic gases, such as hydrogen sulfide and carbon dioxide, from gases and liquids.

The gases and liquids are scrubbed with solutions of ethanolamines (organic alkalies) which remove acidic gases from them. The absorbed acidic gases are then separated from the amine solutions by heating which regenerates the solution for further acid gas absorption. The regeneration takes place because amine salts of weak acids dissociate readily at moderately elevated temperatures, and the amines may be separated from the acidic gases they have absorbed at lower temperatures.

The use of solution reactivation under increased pressure when carbon dioxide is one of the absorbed gases results in more complete stripping and consequent increased acid-gas capacity of the amine solution over the capacities obtainable with atmospheric-pressure reactivation with a consequent decrease in investment and operating costs of the plant. The use of suitable antifoaming agents such as ocenol (oleyl alcohol) eliminates solution carryover where such carryover is the result of foaming due to impurities in the gas.

The use of diethanol amine in treating refinery gases and liquids containing carbonyl sulfide avoids the loss incurred from the reaction of carbonyl sulfide and monoethanol amine.

CHARGING STOCKS.—Among the applications of the process in the petroleum industry are:

1. Purification of refinery and natural gases to eliminate corrosion, to reduce atmospheric pollution, and to recover hydrogen sulfide for conversion to elemental sulfur or sulfuric acid.

2. Purification of gaseous feed stocks for polymerization and chemical plants.

3. Purification of hydrocarbon liquids, including gasoline, propane, butanes, and poly feed stock.

4. Removal of carbon dioxide from hydrogen and synthesis gas mixtures.

5. Recovery of carbon dioxide for commercial use as liquid or as "dry ice" and for use in producing synthesis gas mixtures.

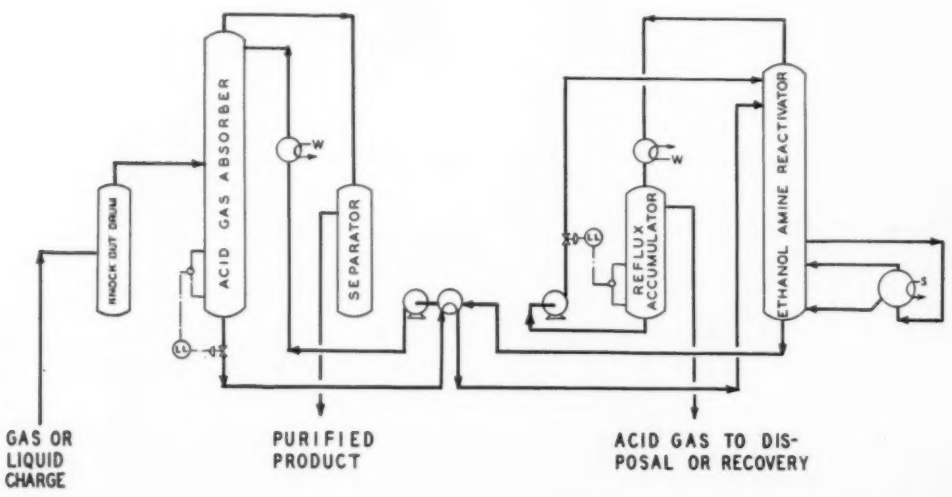
6. Purification of natural gas for pipe-line distribution (including simultaneous hydrogen sulfide removal and dehydration).

MAJOR EQUIPMENT.—Equipment and operating cycle of a Girbotol plant are similar to those of an oil-absorption plant. The raw feed (gas or liquid) is passed through a contactor countercurrent to a stream of lean amine solution that removes hydrogen sulfide and/or carbon dioxide from it. The purified product passes out the top of the contactor to utilization, while the rich amine solution, containing absorbed hydrogen sulfide and/or carbon dioxide, flows through a heat exchanger to a stripper (reactivator) in which the acid gases are separated from the solution by indirect heating and steam stripping.

The acid gas and steam from the overhead of the reactivator passes through a condenser. The stream is condensed and returned to the system and the acid gas is flared or recovered. The lean amine solution from the base of the tower returns to the contactor after heat exchange with the rich amine solution and additional cooling.

Two-stage absorption and reactivation results in greater increase of purification and decreased utility consumption. Solution recovery by distillation in the presence of sodium carbonate or by extraction eliminates difficulties encountered when oxygen is present in the gas stream. The use of mercaptan plant stripping steam for reactivation of the amine solution results in a combination savings of utilities.

Discussion of this process was supplied by its licensor, Girdler Corp., Louisville.



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A MESSAGE TO PETROLEUM REFINERS

BY BRUCE K. BROWN

Deputy Petroleum Administrator, Petroleum Administration for Defense

THE task of guiding the mobilization of the petroleum industry for war or for armed peace has been assigned to the Petroleum Administration for Defense. It is a bitter task with its connotation of armed conflict, particularly since the world has not as yet completed the sweeping up of the debris from the last war. However, this mobilization responsibility has been forced upon the freedom-loving nations, their people, and their industries and most assuredly the petroleum industry and PAD working together can and will achieve the desired degree of mobilization of oil once again.

The specific part that petroleum refiners will be expected to play in the oil-mobilization picture is not yet entirely defined. It is known, however, that when full mobilization is reached there will have to be a very substantial increase in refining capacity, possibly even more than the million-barrel-daily increase which has already been publicized. Much of this increased capacity can be of modern conventional design, since the demand will be for all petroleum products of a quality and in the approximate ratio of normal peacetime conditions.

It is true that all-out mobilization will increase the requirements for such highly specialized military products as aviation gasoline and jet fuels by a very large amount but it is also true that the demands for other less-specialized products will be increased by possibly an equal amount. This is the reason the Petroleum Administration has been encouraging the refining branch of the industry to increase its capacity. In each case thus far in which a refiner has filed a request with Defense Production Administration for a Certificate of Accelerated Tax Amortization applicable to an intended increase in his basic refining capacity, PAD has recommended to DPA the granting of a certificate covering a substantial portion of the total intended investment. PAD desires to see further increases in refining capacity presented for consideration and such projects will be given sympathetic consideration.

Must Install Specialized Equipment

The American petroleum-refining industry must install additional highly specialized refining facilities to meet the specific requirements for all specialized products under all-out mobilization conditions. An analysis is under way as to how best the industry can meet the future demand for greatly increased quantities of aviation gasoline, jet fuels and other products.

Consideration is being given as to whether such increased demands can best be met by the installation of facilities such as specialized alkylation facilities, catalytic reforming, specialized aromatic production facilities, catalytic cracking, or by other means. Even before the completion of this study, PAD has recommended the issuance of 100 per cent Certificates of Accelerated Tax Amortization for new alkylation facilities which certainly will be needed in any mobilization program.

Other special products in addition to aviation gasoline and jet fuel are and will be the subject of support by PAD to meet the expanded defense needs. PAD has supported requests for the installation of facilities for the production of benzene from petroleum in order to assist in overcoming the shortage of this critical material needed for the production of styrene and other needed end products. Other special materials which could be produced from refineries are under constant consideration by PAD, and among these which might be mentioned is the recovery of sulfur from refinery gases and other refinery products.

Sulfur-Recovery Facilities

It is known that the refining industry could do a lot to overcome the shortage of this material by the installation of sulfur-recovery facilities, and PAD is desirous of facilitating the construction of such facilities. Other petroleum specialties such as naphthenic acids, petroleum sulfonates, and various other types of petrochemicals are indicated to be in short supply. PAD requests the petroleum refiners of this country to investigate their own possibilities of producing additional quantities of such critical materials, and within the framework of steel and other material availability and indicated needs for the end products will support programs thereto.

Looking down the mobilization road it seems quite certain that the refining industry will be called upon by PAD to vary its operations from time to time to meet the military demands for special products such as aviation gasoline, and to conserve critical materials such as has already been done by the tetraethyl lead allocation order.

It is the desire of PAD to discharge its obligations regarding the supply of military and civilian petroleum products with a minimum of government controls, and insofar as possible, to achieve the desired results through the Government-industry cooperative technique which proved so successful during World War II. As a Government-industry team the mobilization demand for petroleum products can and will be met and when the mobilization needs are over, PAD and its staff will be only too glad to remove all restrictions and return the industry to its historic place in a free economy.

XUM

North American F-86 Sabres of the 56th Fighter-Interceptor Wing. (Official U. S. Air Force photograph.)

AIRCRAFT GAS-TURBINE FUELS

Everything points towards two types of turbine fuels, one for military and one for commercial or civilian operations

by H. A. Murray*

America's first turboprop transport, the Convair-Turboliner, shown making its first takeoff in San Diego. A modified 40-passenger, twin-engine Convair-Liner commercial transport, the plane is equipped with two 2,750-hp. Allison 501 turboprop engines. The research transport was built by Consolidated Vultee Aircraft Corp. for the Allison Division of General Motors Corp. (Photograph courtesy of Consolidated Vultee Aircraft Corp.)

THREE years ago there appeared in the *January 8, 1948, issue of The Oil and Gas Journal*, a paper entitled, "Jet Fuels for Aircraft."[1] This paper reviewed the jet or turbine-fuel requirements at that time. It dealt with the kinds of fuel required and trends toward newer types. Specifically, the factors covered were: availability, volatility, evaporation losses and vapor locking, low-temperature problems, the effect of fuel composition on combustion, fire hazard, stability, and heating value.

Much progress on turbine fuels and turbine design has been made over this period. The purpose of this article will be to present an up-to-date appraisal on this subject. It will reflect the factors governing the selection of fuels both for military and commercial or transport types of aircraft. Since recent world conditions have imposed tighter security controls, much of the recent technical data cannot be disclosed because of its "classified" nature.

In the military field the transition from piston engine to turbine-powered types has been greatly accelerated. Recent combat experience

TABLE 1—GENERAL REQUIREMENTS OF MILITARY AND COMMERCIAL TURBINE FUELS

	Military	Commercial
Availability	Maximum	Moderate
Cost	Moderate	Lowest
Flammability—fire hazard	Secondary	Lowest
Minimum starting temperature	—65° F.	—40° F.
Volatility—its effect on combustion	Maximum combustion efficiency, no deposits	Maximum combustion efficiency, no deposits
Storage stability	1-2 years	1-2 years
Heating value	Highest	Highest
Odor	Sweet	Sweet

*The Texas Co., Technical and Research Division.

with jet fighters has been exceptionally favorable especially when these aircraft were operated under the designed conditions. The growth of turbine powered types in service may be realized by comparing the rapid increase in jet-fuel procurements as compared with aviation gasoline.

During the past year several promising types of turboprop engines (propeller turbine) have appeared in the United States. These new engines already are being test flown and being installed in new designs of patrol and transport models of aircraft. Here again the piston engine is giving way to the turbine.

Chronologically the recent changes that have taken place in types of fuels may be summarized:

1. JP-2 (AN-F-34) grade was discontinued about 3 years ago.

2. JP-3 (AN-F-58) MIL-F-5624 has been introduced, extensively tested in laboratory and in service, and adopted for a majority of turbine-powered aircraft.

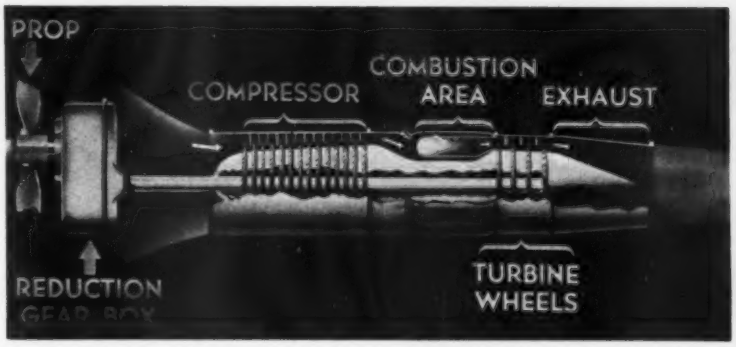
3. JP-1 (AN-F-32) MIL-F-5616 will be procured for older models of jet-powered aircraft that have not been modified to use JP-3 grade. Most of the requirements of JP-1 grade will be outside of the United States. Eventually this grade will be discontinued.

In addition studies are being made covering a fourth type of lower vapor pressure (1 lb. R.v.p.) as a possible future replacement of JP-3 grade. The principal objection with the JP-3 grade in future types of aircraft may be excessive evaporation losses and vapor locking.

In the commercial field we find some recent and noteworthy events concerning the application of turbine engines to cargo and passenger transports. In England the British now have test-flying a number of turbine-powered transports. The most interesting types are the DeHavilland "Comet" with four turbojet engines and the Vickers Viscount with four turboprop engines. In Canada the A. V. Roe Co. last year introduced the "Jetliner" with four turbojet engines, that is equally promising. In the United States much credit goes to Convair (Consolidated-Vultee Aircraft Corp.) and Allison Division of General Motors for building the first turbine powered transport, the "Turboliner." This ship has two Allison model 501 turboprop engines of 2,750 equivalent shaft horsepower each. It made its first test flight only a few months ago.

General Requirements of Turbine Fuels

One of the advantages of the basic gas turbine is its ability to utilize a wide variety of fuels. In stationary service these turbines have recently shown successful operation on fuels from gaseous types as the most volatile to Bunker C as the least volatile. According to recent reports there is even some promise of successful operation on powdered coal.



HOW THE TURBOPROP ENGINE OPERATES

Like the turbojet the turboprop is a gas-turbine engine. But in the turboprop the turbine is connected through a drive shaft and reduction gears to a special type propeller. Air enters the compressor which feeds it under high pressure into the combustion chamber where it is mixed with fuel and ignited. Thrust of the combustion gas drives the turbine which generates power to operate both compressor and propeller. (Photograph courtesy of Allison Division of General Motors Corp.)

In aircraft applications the necessity for designing to minimum weight and the extremely wide range of temperatures and altitudes encountered impose many restrictions on suitable types of fuels as compared with stationary, railroad, or other applications.

The general requirements of turbine fuels for both military and commercial service appear in Table 1. These requirements reflect the latest performance data in various models of turbines, operating conditions of both military services and commercial airlines and current operations of the petroleum industry. From this table we find that both classes have more or less similar requirements concerning combustion efficiency, deposits, stability, odor, compatability with fuel system materials, and heating value. The specific requirements that differ are availability, cost, flammability, and low-temperature properties.

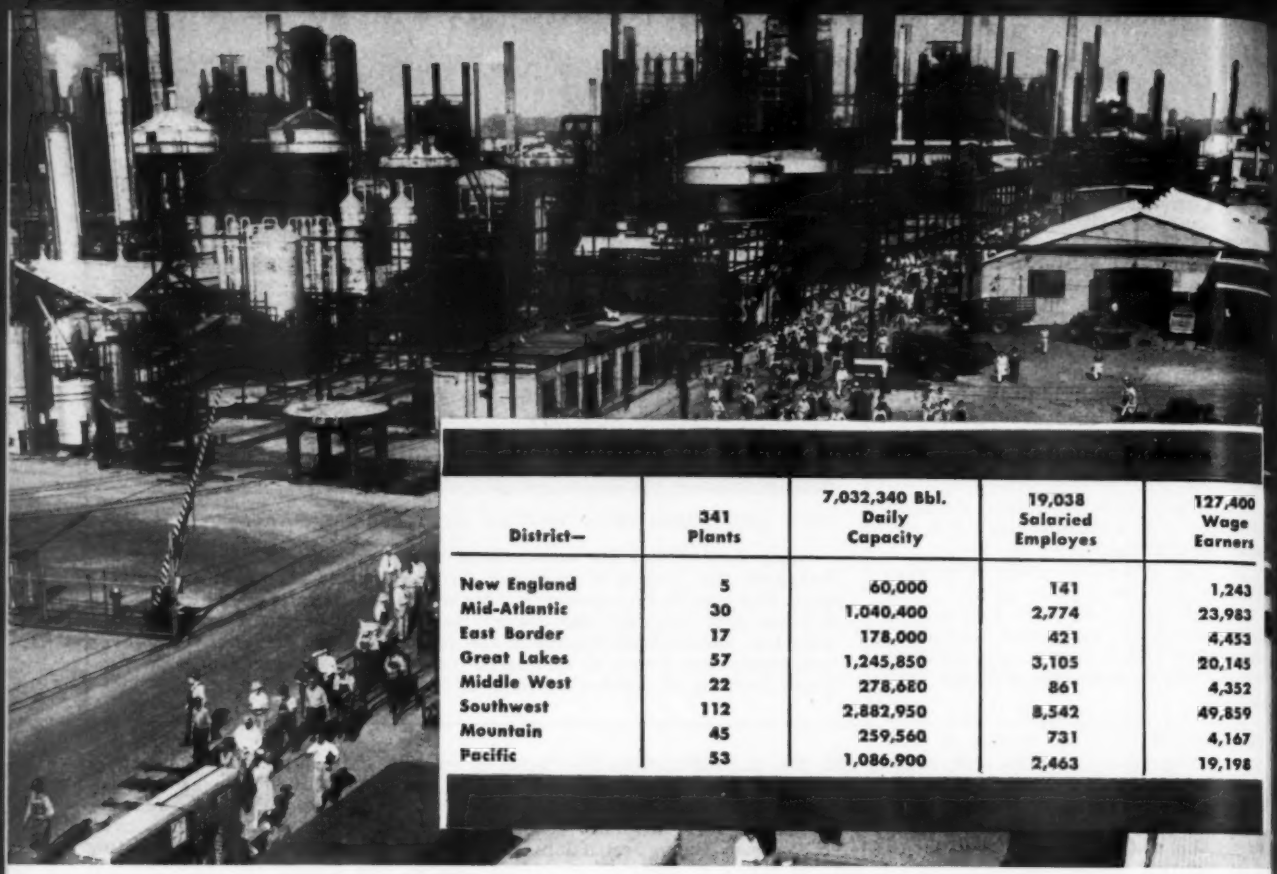
1. Availability.—The most important consideration from the military viewpoint is availability. Unless a fuel can be produced in sufficient quantities during an emergency, it is of little value no matter how exceptional it may be from a performance

(Continued on page 271)

TABLE 1—SPECIFICATIONS OF AIRCRAFT GAS-TURBINE FUELS

Specification requirements—	JP-1 MIL-F-5616 (AN-F-32)	JP-3 MIL-F-5624 (AN-F-58)	Proposed commercial (No. 1 fuel oil)
Color, Saybolt min.	+12	+12	.....
Gravity:			
Specific 60/60° F.	0.850 Max.	.....	.....
A.P.I. /60° F.	.....	45-63	.....
Flash, tag. closed °F. min.	110	.....	*120
Distillation, temp. °F.:			
10 per cent evap.	410 Max.	.....	{ 350 Min. { 420 Max.
90 per cent	490 Max.	400 Min.	
95 per cent			460 Min.
E.p.	572 Max.	600 Max.	600 Max.
Residue per cent	1.5 Max.	1.5 Max.	1.5 Max.
Loss per cent	1.5 Max.	1.5 Max.	1.5 Max.
Reid vapor pressure, psi.	.....	5.0-7.0	.....
Viscosity, c.s.:			
At 100° F. maximum	.....	.....	2.0
At —40° F. maximum	10.0	.....	.....
Freezing point, °F. maximum	—76	—76	—40
Gum, accelerated mg./100 ml. maximum	†8.0	†20.0	‡20.0
Residue, air jet, mg./100 ml. maximum	5.0	10.0	10.0
Corrosion, "air well" copper strip	(§)	(§)	Slight
Sulfur, total per cent maximum	0.20	0.5	0.5
Mercaptan sulfur content, per cent maximum	¶0.005	¶0.005	¶0.005
Aromatics, volume per cent maximum	20	25	25
Bromine No., maximum	3.0	30.0	30.0
Heat of combustion, net B.t.u./lb. minimum	.....	18,400	.....
Water tolerance	(‖)	(‖)	(‖)
Inhibitor content, lb./5,000 gal. maximum (approved type)	.....	1.0	1.0

*Pensky Martin; †16-hour aging period; ‡14-hour aging period; §No corrosion, slight discolor, maximum; ¶Mercaptan sulfur may be waived if fuel is sweet in doctor test; ‖Substantial immiscible maximum change either layer 2 ml. JP-1 commercial and 1 ml. JP-3.



District—	341 Plants	7,032,340 Bbl. Daily Capacity	19,038 Salaried Employes	127,400 Wage Earners
New England	5	60,000	141	1,243
Mid-Atlantic	30	1,040,400	2,774	23,983
East Border	17	178,000	421	4,453
Great Lakes	57	1,245,850	3,105	20,145
Middle West	22	278,680	861	4,352
Southwest	112	2,882,950	8,542	49,859
Mountain	45	259,560	731	4,167
Pacific	53	1,086,900	2,463	19,198

States included in the eight different refining districts are:

New England—Massachusetts, Rhode Island.
Mid-Atlantic—New Jersey, New York, Pennsylvania.
East Border—Delaware, Georgia, Kentucky, Maryland, South Carolina, West Virginia.
Great Lakes—Illinois, Indiana, Michigan, Minnesota, Ohio, Wisconsin.
Midwest—Kansas, Missouri, Nebraska, South Dakota.
Southwest—Alabama, Arkansas, Louisiana, Mississippi, Oklahoma, Tennessee, Texas.
Mountain—Colorado, Idaho, Montana, New Mexico, Utah, Wyoming.
Pacific—California, Oregon, Washington.

A Census of Plant-Capacity Distribution and Manpower in the United States Refining Industry

A CENSUS of plant-capacity distribution and allied data on the United States petroleum-refining industry recently was undertaken by The Oil and Gas Journal. An interesting phase of the project was to align plant capacity rating with the manpower employed in all of the nation's refineries.

The total of 341 operating refineries studied had a combined crude-oil charge capacity of 7,032,340 bbl. per day. In these plants, 19,038 salaried employes and 127,400 wage earners were engaged (total of both, 146,438).

Of the 341 refineries analyzed, it was found that the 24 largest plants in the United States have 3,328,000 bbl. per day of the total crude-oil charge capacity represented by the 341 plants. These 24 largest refineries have 76,090 employes. The 24 largest plants operate 47.2 per cent of the aforementioned national total refining capacity. The 24 largest refineries range in size from a maximum of 315,000 bbl. down to 69,000 bbl. daily for the twenty-fourth plant (see table).

Job Functions—Over-all for 341 Plants

Salaried employes.—Actual job functions analyzed for the 19,038 salaried employes (total 341 refineries) first involved a division by title, and then by departmental pattern. Following are titles included under this category (considerable standardization of terms between plants was necessary to reduce titles to this workable number):

19,038 SALARIED EMPLOYES—POSITIONS INCLUDED

President	Warehouse supt.
V.P. in charge mfg.	Warehouse foreman
Chief process engr.	Master mechanic
Asst. chief engineer	Asst. master mech.
Supervisory engineer	Mach.-shop foreman
Superintendent	Maint. supervisor
Asst. superintendent	Maint. engineer
Night superintendent	Dir. of research
Process engineer	Research engineer
Chief chemist	Design engineer
Asst. chief chemist	Construction engr.
Chemist	Elec. supervisor
General manager	Instr. supervisor
Asst. gen. manager	Safety engineer
General foreman	Asst. safety engineer
Asst. gen. foreman	Manager, stores
Shift foreman	Office manager
Chief engineer	Chief accountant
Asst. chief engineer	Chief technologist
Engineer	Head draftsman
Mgr., dispatching	Mgr., cracking
Mgr., distilling	Mgr., marine loading
Mgr., lube oils	Area foreman
Mgr., asphalt	Mgr., utilities
Mgr., compounding	

Wage earners.—It was found that over 700 titles of job classifications are used for wage earners in the 341 refineries studied in detail. By consolidations and standardizing, the following 41 job classifications were used:

127,400 WAGE EARNERS—41 JOB CLASSIFICATIONS

Stillman	Welder
Controlman	Pump repairman
Still fireman	Insulator
Stillman assistant	Rigger
Operator	Rigger helper
Wax press dumpers	Mechanic
Repairman	Cement finisher
Pumper	Truck & tractor oper.
Gager	Carpenter
Instr. repairman	Labor foreman
Clay mixer	Laborer
Treater	Barrel-house helper
Treater assistant	Tube cleaner
Warehouseman	Pressureman
Oil tester	Electrician

Oil tester apprentice	Metallizer
Compounder	Painter
Tank-car loader	Rodman
Utility man	Transitman
Pipe fitter	Tinner
Construction man	

Departmental pattern. — Arrangement of the total refining personnel on this basis was as follows:

	Total employes
1. Administration	8,168
Executive personnel	1,679
Bookkeeping and accounting	2,929
Sales	146
General clerical	3,415
2. Technical services	16,580
Process engineering and research	5,743
Equipment and design	1,612
Laboratory control and testing	9,225
3. Production or manufacturing	28,409
Process management	443
Distillation (steam and vacuum)	4,978
Cracking (thermal and catalytic)	4,393
Alkylation	1,903
Gas recovery and stabilization	2,635
Dewaxing	6,150
Finishing (solvent extraction, acid and clay treating, lube-oil compounding, grease making, acid and catalyst recovery)	7,907
4. Pumphouse	7,468
5. Maintenance	52,132
Planning and control	1,906
Equipment repair and maintenance	3,221
Machine shop	7,029
Instrument repair	2,051
Structural maintenance	7,907
Pipe fitting and covering	14,497
Plate fabrication and repair	4,246
Tank-car repair	732
Yard labor	10,543
6. Utilities	4,686
7. Warehouse, shipping, receiving and storage	17,133
Supervisory and clerical	4,541
Container repair, preparation and filling	6,150
Loading (truck, ship, railroad)	4,832
Salvage yard	1,610
8. Protection and custodian	11,862
	146,438

Headquarters Locations

Headquarters office locations for 195 of the 341 refineries were concentrated in 18 cities. New York was first, being headquarters for 53 refineries, followed by Los Angeles (area) with 34. Tulsa and Chicago were headquarters for 15 plants each, while Pittsburgh and Bartlesville were headquarters for 10 each. (See table.)

HEADQUARTERS OFFICE LOCATIONS FOR U. S. REFINING OPERATIONS (HOME OFFICE CONTROL)

City—	No. of refining plants
New York	53
Los Angeles and vicinity	34
Pittsburgh	10
Chicago	15
Philadelphia	4
Houston	6
San Francisco	9
Bartlesville, Okla.	10
Ponca City, Okla.	8
Tulsa	15
Dallas	5
Cleveland	6
Wichita	4
Denver	8
New Orleans	2
Baltimore	1
Detroit	2
Shreveport	2
Total 18 cities	195

Note—Twelve cities are home office points of control for 85 per cent of total refining capacity.

THE 24 LARGEST PLANTS IN THE U. S. OPERATE 47.2% OF TOTAL REFINING CAPACITY

(3,328,000 bbl. per day)

Have Total of 76,090 Employes

Company and plant location—	Crude-oil charge capacity, bbl. per day	Refinery type
Humble Oil & Ref. Co.: Baytown, Tex.	315,000	Comp.
Esso Standard Oil Co.: Baton Rouge, La.	245,000	Comp.
Gulf Oil Corp.: Port Arthur, Tex.	230,000	Comp.
Standard Oil Co. (Ind.): Whiting, Ind.	192,000	Comp.
The Texas Co.: Port Arthur, Tex.	190,000	Comp.
Esso Standard Oil Co.: Bayonne, N. J.	165,000	Comp.
Magnolia Pet. Co.: Beaumont, Tex.	150,000	Comp.
Cities Service Refining Corp.: Lake Charles, La.	150,000	S-C
Sun Oil Co.: Marcus Hook, Pa.	140,000	Comp.
Standard Oil Co. of California: Richmond, Calif.	138,000	Comp.
General Pet. Corp.: Torrance, Calif.	125,000	S-C
Shell Oil Co.: Wood River, Ill.	120,000	Comp.
Standard Oil Co. of California: El Segundo, Calif.	117,000	S-C
Atlantic Refining Co.: Philadelphia	117,000	Comp.
Shell Oil Co.: Houston	115,000	Comp.
Pan American Refining Corp.: Texas City, Tex.	114,000	S-C
Gulf Oil Corp.: Philadelphia	107,000	S-C-L
Richfield Oil Corp.: Watson, Calif.	100,000	S-C
Tide Water Associated Oil Co.: Avon, Calif.	85,000	Comp.
Sinclair Refining Co.: Houston	90,000	Comp.
East Chicago, Ind.	90,000	Comp.
Marcus Hook, Pa.	90,000	S-C
Tide Water Associated Oil Co.: Bayonne, N. J.	74,000	Comp.
Union Oil Co. of Calif.: Oleum, Calif.	69,000	Comp.
Total	3,328,000	

EXPLANATION OF ABBREVIATIONS USED IN TABLES

Refinery Type:

(Comp.)—Complete refinery with S-C-L facilities plus A and/or W.
(S)—Crude-oil distillation.
(C)—Thermal and/or catalytic cracking.
(A)—Asphalt. (W)—Wax.
(L)—Lubricating oils.

Census Shows Refining Manpower=146,000 Plus!

Looking over the results of the Journal's "Refining Manpower-Capacity" Census are members of the field organization compiling the data: D. W. Wilson; J. W. Brownlee; D. B. Miller; K. B. Barnes, managing editor; and R. B. Tuttle, associate editor. Detailed information on the Journal's annual survey of information for individual refineries appears in this issue on pages 329-347.

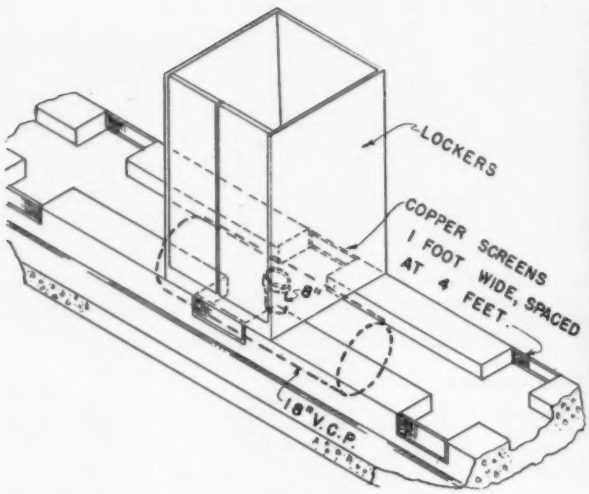


Fig. 1—Circulating air system at Latonia and Lima locker rooms.

Fig. 3—Locker room at Lima refinery.

Teamwork Accomplishes Worthy Results In Sohio's Refinery-Construction Program

by E. M. Salathe*

"We believe the Sohio expansion program has resulted in a freer interchange of ideas within the company than has previously taken place. Interdepartmental conferences with refinery personnel, designers, and specialists have fully utilized the background and experience of all, and have successfully combined the experience of the professional and the practical man. Briefly, we have faced unusual problems and have produced adequate and satisfactory solutions."

Fig. 2—Lunch room at Latonia refinery.

EXPANSION in the highly competitive petroleum industry has from the early days been accomplished by various combinations of the bizarre and the commonplace.

Many times the difficulties caused by the attempted applications of the accepted solutions to engineering problems have resulted in innovations or novel and unique results.

Throughout the past 3 years Sohio has been engaged in a $100,000,000 expansion program with much emphasis being placed on refinery construction.

This article will deal only with the refinery phase of the expansion program and develop briefly what problems have arisen and what solutions have been applied.

A threefold emphasis has been established as a yardstick by which to judge progress throughout the program. The specific points of the analysis are:

1. What problems have arisen?
2. What has been done about the problems?
3. How good were the solutions to the problems?

Throughout the refinery expension program the Sohio engineering and technical staffs have been responsible for the development, coordination, and execution of the separate projects. Teamwork between these groups and the various refineries has been the

*Standard Oil Co. (Ohio), Cleveland.

keynote in the expansion which started at Sohio's Latonia, Ky., refinery.

Buildings

Locker rooms.—The initial problem was the design and construction of adequate locker and cafeteria space at Sohio's refinery at Latonia. Mandatory requirements were that this building be located at the refinery entrance because of space considerations. Additional requirements were that the architecture be attractive and that the interior equipment be adequate to meet the requirements of the refinery and any visitors to the plant.

In the development of this facility the decision was made to incorporate both the cafeteria and the locker-room facilities in one building to save space and to provide a greater degree of convenience for the personnel.

The major problem here was to effectively ventilate so that the usual locker-room odors would not permeate the entire building. Effective ventilating facilities were provided by designing air ducts for forced circulation of air into the locker bases. (Fig. 1.)

From the main air duct, openings are provided to place each locker under a slight positive pressure. As the air stream passes from the lockers into the room a great deal of the unpleasant odor is removed and exhausted to the outside air.

The remainder of the locker room follows conventional design although a great deal of attention was given the problem of space arrangement to eliminate crowding and to provide a pleasant environment in which to prepare for or leave the job.

Cafeteria.—The kitchen facilities in this building have been designed so that 125 meals per hour may be prepared and served from serving racks located at the entrance of the dining area.

The dining area, incidentally, is oak paneled and floored with asphalt tile so that it may serve double duty by providing space for community or company functions. (Fig. 2.) This design has proven to be good so far as economy is concerned, and has met the demands of an ever-growing social-consciousness.

More than a year later, when it became necessary to plan Sohio's expansion at the Lima, Ohio, refinery, it was possible to rely on former experience and build a fine modern locker building which has been progressively expanded with expanding plant needs. While the basic designs for the Lima installation, shown in Fig. 3, resembled the Latonia locker room, much more emphasis was placed on ventilating and heating facilities and on the application of antiseptic flooring for the shower stalls.

Since the Lima plant covers a much larger land area, consideration was given to the central location of the building to minimize worker travel time between work locations and to

Fig. 4—Exterior view of Latonia shop building.

Fig. 5—Interior view of Latonia shop building.

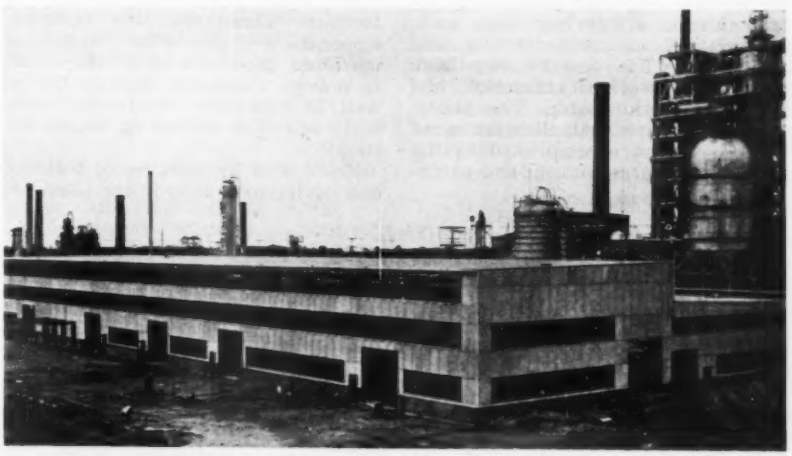


Fig. 6—Exterior view of Lima shop building.

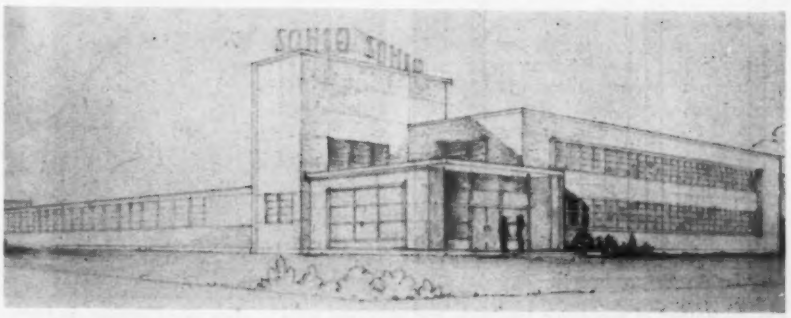


Fig. 7—Lima office and control laboratory building.

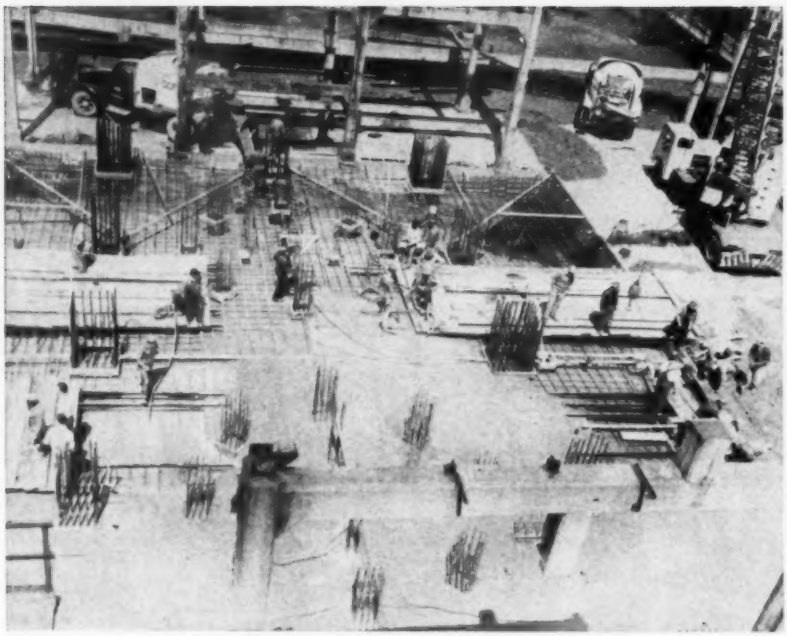


Fig. 8—Pouring slab at the T.C.C. unit at No. 1 refinery.

decrease the cost of providing the necessary facilities.

Maintenance shops.—Sohio has built new shops buildings incorporating space for mechanical and supervisory personnel, warehousing facilities, and new modern tools at both the Latonia and Lima plants, (Fig. 4). In both cases, efforts have been made to provide adequate lighting and ventilation. The reward has been heightened worker efficiency and improved workmanship. The photographs are a visual illustration of what has been accomplished in the way of space arrangement and equipment layout.

Fig. 5 shows the shop interior of the Latonia shop building. The high bay has facilities for handling heavy and awkward materials and equipment for the fabrication of many commonplace maintenance items. The low bay houses small-tool and instrument repair shops and offices for foremen. Throughout the building, emphasis was placed on location of machines, pipe, and boiler-shop tools to provide maximum accessibility as well as minimum interference with other activities carried on within the shop.

Faced with the problem of building and equipping a shop in the Lima refinery a year later, the knowledge gained at Latonia was a real advantage. In many ways the Lima refinery shop building (Fig. 6) resembles the Shell Oil Co. installation in Houston, about which there has been much comment in the industry in the past year. The building is 140 by 340 ft. The exterior walls are brick to a height of 4 ft., the remainder transite. The roof is bonded asphalt, gravel surfaced, and insulated with 3-in. fiberglass. Work area within the building is 47,600 sq. ft. Objectively, this area, 1.1 acres, is sufficient to handle maintenance activities of a 40,000-bbl. per day refinery.

A brief outline of special interest features within the building follows.

The lighting is of the incandescent and mercury type and is designed to give 30-ft. candles on the entire shop area.

Planned and installed as a part of the basic design is a bridge crane with 15-ton main hoist capacity and 3-ton auxiliary hoist. As auxiliaries there are 12 jib cranes for handling individual work.

Each maintenance foreman has an office which averages 120 sq. ft. of space and is lighted so that the working area has available 50-ft. candles of light without the necessity for auxiliary lighting. All offices have asphalt-tiled floors and are easily available either to the interior or the exterior of the building. All offices are equipped with forced ventilation. By the application of acoustical materials, these offices have a reduced noise level which permits routine duties to be carried on easily, quickly, and efficiently.

Office and laboratory.—The culmination of construction at the Lima refinery has been in a new office and laboratory building (Fig. 7) which supplants to a large degree the facil-

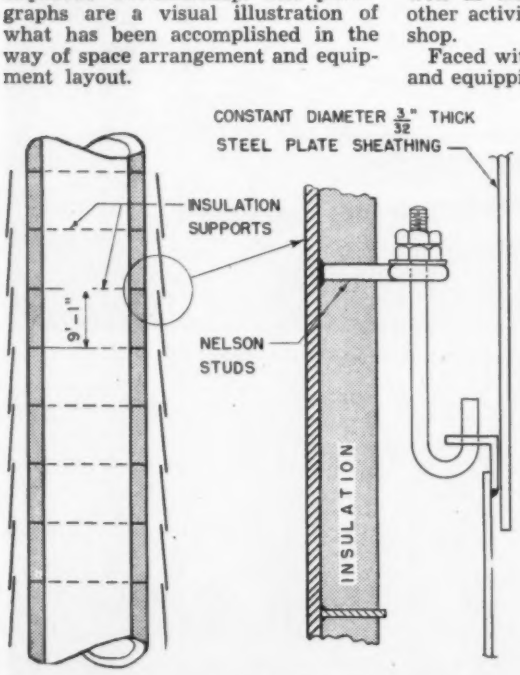


Fig. 9—Method of supporting insulation and attaching steel sheathing to vessels.

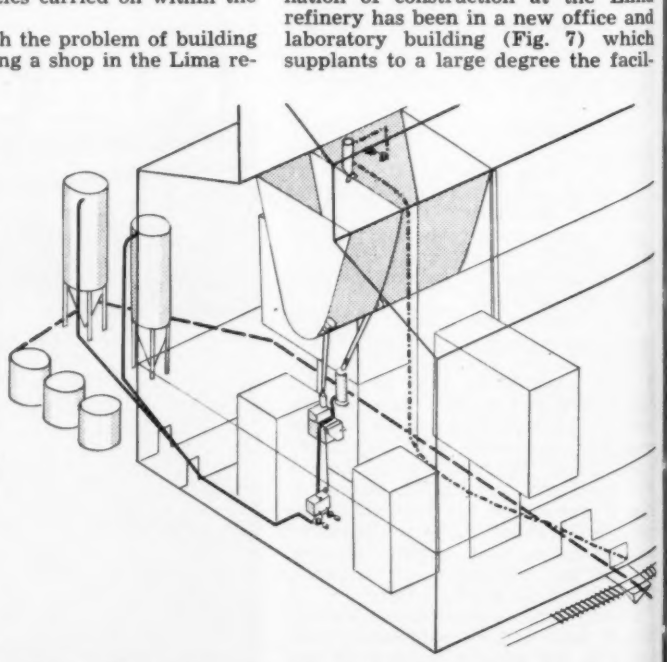


Fig. 10—Phantom diagram of chemical-handling equipment in water-treating system at Lima refinery.

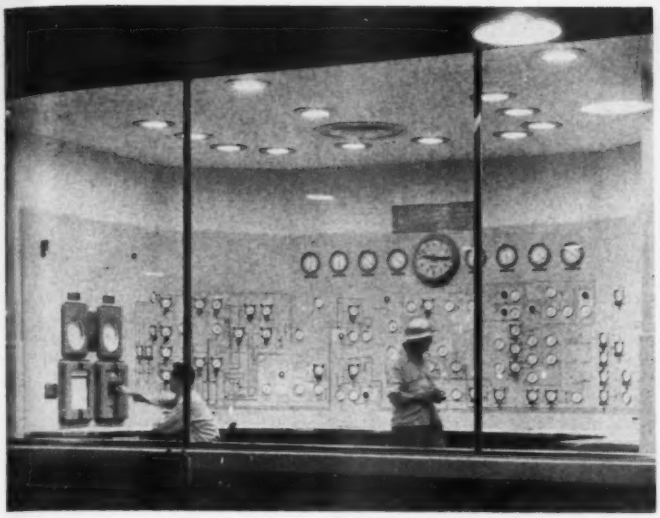


Fig. 11—Lube-oil-plant control room.

Fig. 12—Clay-handling head tank.

ities of existing buildings in service since the early part of the century. This building, located on a federal highway, was designed to provide eye appeal for the public as well as to provide functionally the services of a control laboratory and office space.

The building is L-shaped with one wing housing the laboratory, and the remaining wing housing the refinery offices and staff. Both portions of the building were designed on the modular principle for ease in future rearrangements of space. The sections of the building are connected through a common entranceway. Immediately above the entrance, the penthouse arangement houses the air-conditioning and refrigeration equipment. In the laboratory, fume hoods collect and expel all fumes. The service piping has been arranged within a monitor section immediately above the center hallway so that changes resulting from future demands for arrangement of laboratory space may be easily met.

Provision for expansion was anticipated. The present building program was planned to house the laboratory, office, and supervisory personnel, but the initial design of this building will permit future wings to accommodate the engineering department and line foremen without destroying the architectural symmetry nor the functional qualities of the building.

Unit Construction

Power supply. — Utilities and the logistics of utilities are prime factors when considering new installations or the expansion of existing operations. Electric power as a major utility is fairly recent within the industry for two reasons. First, the reliability of electric power has been questionable in the past. Second, a complete line of equipment for hazardous locations has been developed only within the past 25 years.

The capacity of the Lima refinery has been stepped up to 40,000 bbl. per stream day and the solvent lubricating-oil plant installed by maximum use of electric power, without materially increasing the quantity of water taken from the ground or the capacity of the boiler house. The following description is indicative of the type planning necessary for the introduction of power on an extensive scale.

The power supply enters the multiple refinery substation from two separate sources located within the city of Lima. The transformation of power from 34,000 kv. down to 4,160 volts is through three 5,000-kva. transformers. Two of these transformers are for the cat cracker and crude coker, and the other is for the lube plant. The load on the Lima refinery has increased from the original load of 1,200 to 13,000 kva. per month. including the new lube plant which went on stream during the autumn of 1950.

Power consumption for the Lima refinery at the present time is equivalent to that required to light a city of 50,000 homes.

One unusual portion of the power system is the type of control for the blower motors of the cat cracker. On a voltage disturbance, the pull-out relays operate. This automatically trips the breaker controlling one of the blower motors, taking the motor completely off the line. The pull-out relay of the othe motor simply removes the motor field, automatically places the motor in its starting cycle, and accelerates and resynchronizes this blower motor. When this motor is back on the line, the breaker for the first machine is automatically closed. The motor goes through its starting cycle and is automatically placed back on the line.

On a complete loss of voltage on the incoming lines serving the refinery, both motors are automatically removed from the line. After voltage is restored, one motor automatically tries once to come back on the line. The second motor must be started manually. By removing the motors from the line on a complete outage,

(Continued on page 318)

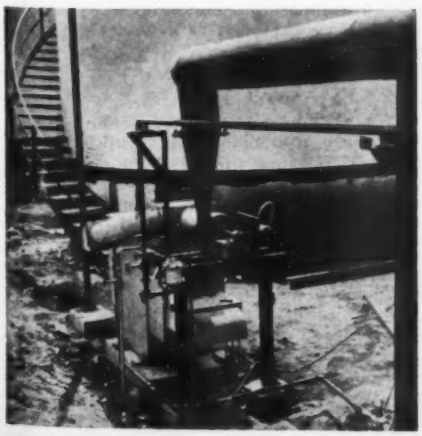
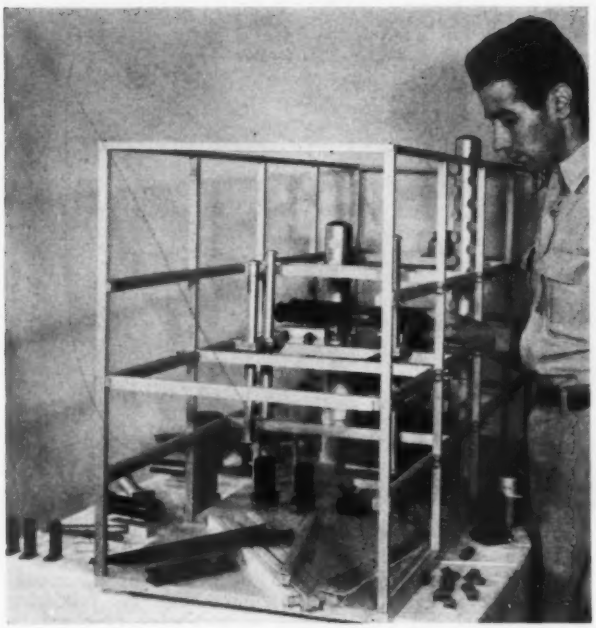
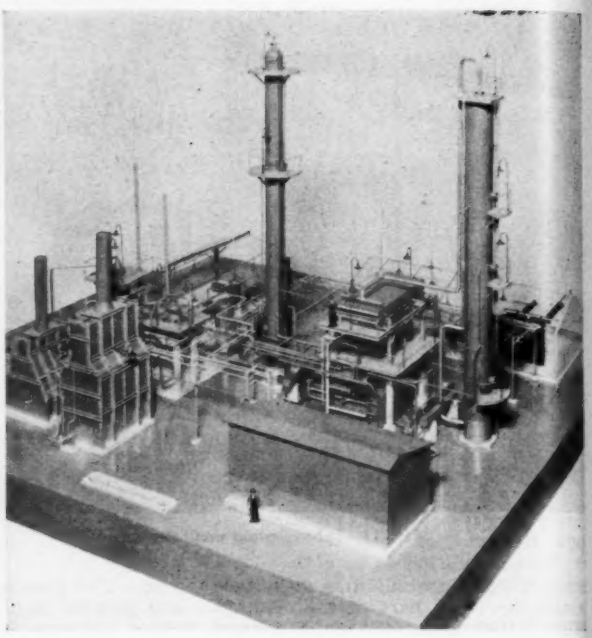


Fig. 13—Air-conditioning installed on finished lube-stock tankage.

Fig. 14—Key-actuated metering equipment at No. 1 refinery.



Scale models such as this one is built up to determine optimum arrangement of equipment. Preliminary-study scale models of this type are useful in coordinating operating and maintenance problems on arrangement of major equipment items.



Scale model of a Platforming unit. Built to accurate scale, this model incorporates many details which are useful in operator-training programs. This particular model was employed by Universal Oil Products Co. in introducing the new process.

Once scornfully regarded as an expensive toy, a new engineering tool is gaining widespread acceptance. This interesting tool, the scale model, functions by

Taking the "Greek" Out of Blueprints

by H. J. Bowen*

SCALE models are gradually being recognized as valuable engineering tools in the process industries. Production cost of models has been considerbly reduced in the past 3 years, encouraging wider use by engineers who formerly regarded them as expensive toys.

A model of a proposed refinery can be used in series by three groups: designers, construction forces, and operating personnel.

The primary function of the model is to translate the "Greek" of blueprints into plain English. This greatly increases the efficiency of scores of people concerned with design, construction, and startup of a new plant.

Design Applications

The finished models pictured here were built from preliminary or final drawings, and were used to detect interferences, omissions, waste space, safety hazards, and accessibility of valves and other equipment.

A new development of recent months in our company is the use of models for actual layout of equipment and piping, before drawings are made. The "preliminary - study" structure pictured is used to establish optimum equipment layout, bay size, and minimum building dimensions, preparation—to a final-arrangement model. Floor heights and bay sizes are adjustable, and all equipment may be moved about as desired. Using this planning model, the designer can bring in operating and maintenance people and quickly reach agreement on major arrangement problems, since everyone can see the principal variables involved.

After equipment arrangement and building design are established, the model maker (who has design experience) goes to work right alongside the designers in the drafting room and installs pipe in the model, according to the flow sheet. The model now contains true structural members. The model maker first determines the shortest practical pipe run and then modifies it to fit process conditions. For example, a piece of wire is run from the discharge of pump "A" to the top of storage tank "B" as specified by flow sheet. Expansion loops, control valves, or other necessary features are installed and the pipe runs are given adequate clearance and support.

The piping study, in any complex job, can be performed much faster in three dimensions than in two, simply because the designer can see all the variables governing the pipe layout. When a complex pipe layout is made in two dimensions (drawings), the designer has to wade through a huge amount of research work, looking up possible interferences with the steel structure, electrical systems, concrete foundations, and other equipment. Even when the research is finished there is still a formidable checking job to be done.

When the model is completely piped, the designer makes final piping drawings from it. There are no preliminary drawings. Double line

*President, Industrial Models, Arden, Wilmington, Del.

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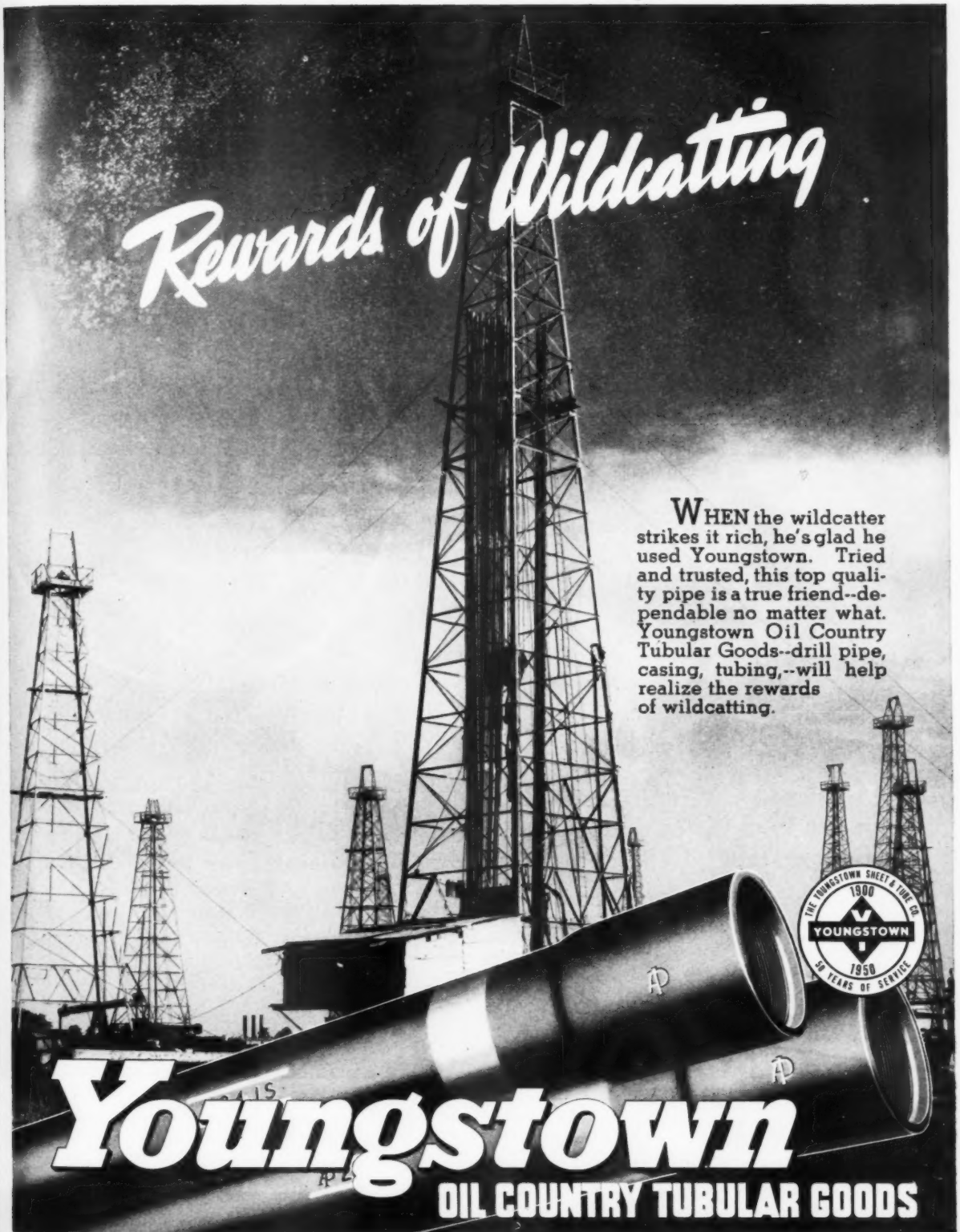
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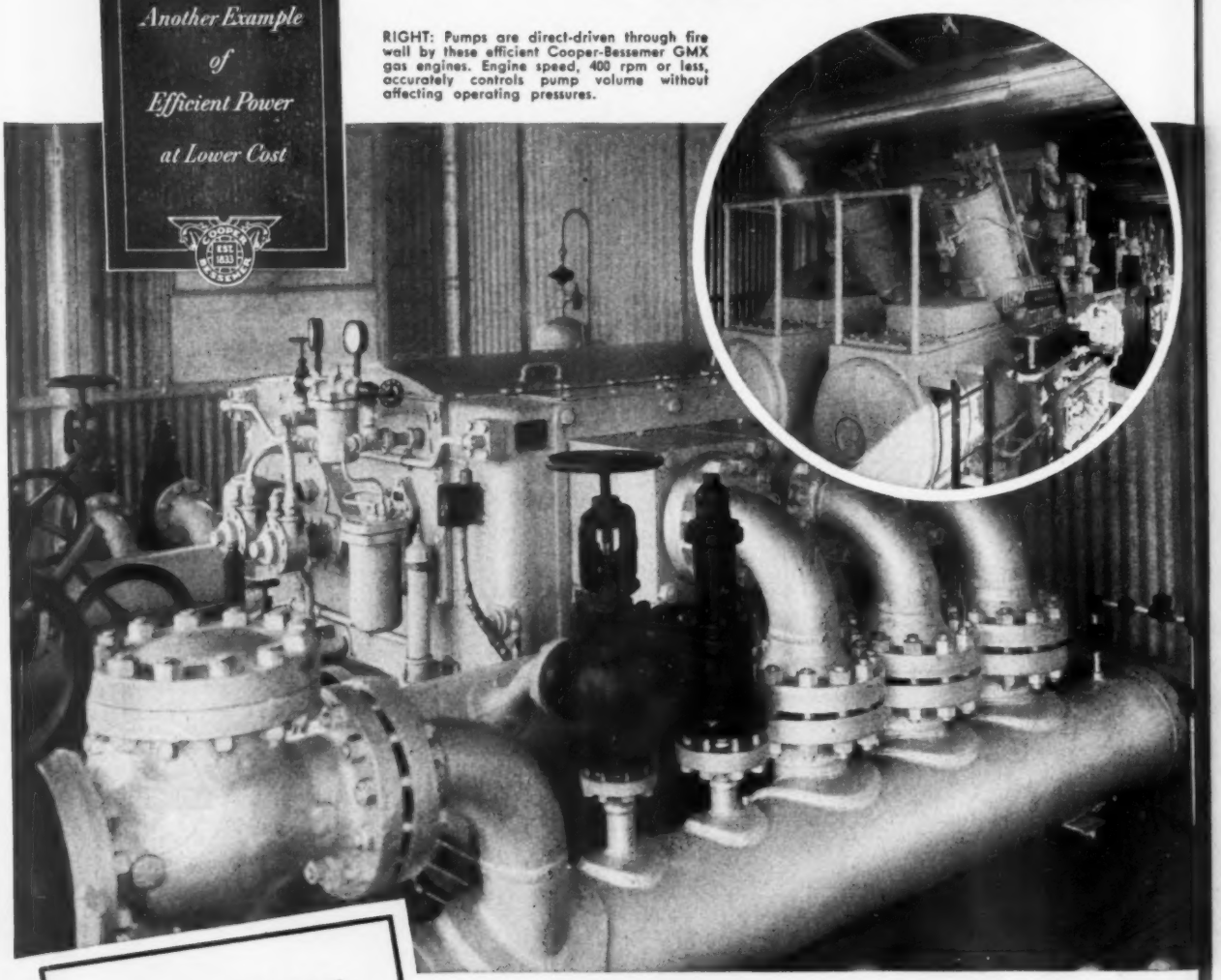
Another Example of Efficient Power at Lower Cost

RIGHT: Pumps are direct-driven through fire wall by these efficient Cooper-Bessemer GMX gas engines. Engine speed, 400 rpm or less, accurately controls pump volume without affecting operating pressures.



ABOVE: One of two 6-cylinder Cooper-Bessemer Twin-Line pumps handling lean oil for methanizing and high pressure absorbing at Sun Oil's Starr County Gasoline Plant.

TWIN LINE

Liquid Pumps

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Starr County Gasoline Plant

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The pump shown opposite is one of two now in Sun Oil's service. The high pressure side of each delivers 248 gpm at 1100 psi. The low pressure side, or first stage, has a capacity of 388 gpm at 225 psi, the excess going to the low pressure demethanizer. Each pump is direct-driven by a Cooper-Bessemer GMX gas engine at 400 rpm, or less, eliminating all need for gearing. Volumes are accurately controlled by varying engine speeds without affecting the operating pressures.

With prolonged 92% mechanical efficiencies and 96% volumetric efficiencies, these units are maintaining operating economy seldom equalled.

The extreme flexibility and simplified drive, of Cooper-Bessemer Twin-Line pumps make them suitable for a broad range of services. Maybe they can save *you* important money. Simply check with the nearest Cooper-Bessemer office.

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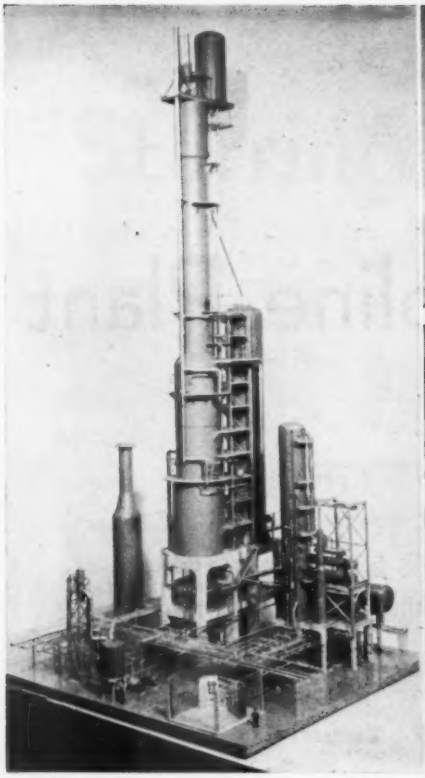
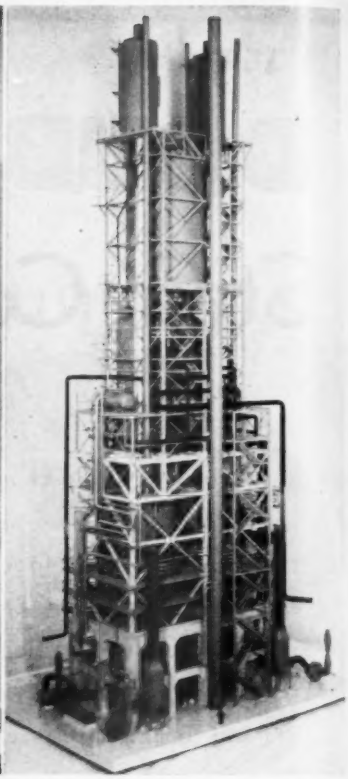


Scale model of the new Houdriflow unit now being built for Shamrock Oil & Gas Corp., at Sunray, Tex. This unit is scheduled for operation soon.

Model of the Thermofor air lift catalytic cracking unit developed by Socony-Vacuum Oil Co., Inc. This model is one of several made for this type of cat cracker.



This model of the new Thermofor unit built for Standard Oil Co. (Ohio) at its Cleveland refinery was used in many different and interesting ways.

drawings are of course obviated since interferences are picked up and corrected in the model. There is very little checking to be done. There are no superfluous elbows, no valves or manholes out of reach, no safety hazards. The result is faster and better design at lower cost.

Use for Construction

By disclosing interference and omissions, the model method of plant layout obviates delay and expense in the field. Its greatest value for construction, however, is to increase the efficiency of the two biggest crews in the field, steel workers and pipefitters.

Equipment placement can be planned with the model, both as to chronology and method. What vessel should go in the structure first, what beams and windbracing should be deferred, are typical of the questions such models answer immediately.

The largest part of installation labor costs goes to the pipefitters on many projects. There are several examples where a model has upped the efficiency of this group on chemical and petroleum installations. Since the model can show virtually all pipe (usually 1-in. and larger) and valves, and can be color coded, it gives the pipefitter a quick picture of where the pipe must go. This does not imply that the model is a substitute for piping drawings. However, there are many pipes, particularly small service lines, that could be installed from the model without drawings. Where a model must be used by several pipe crews working in different areas, it is simply sectionalized or photographed, or both.

Other construction crews can use the model since it shows foundations above grade, all structures, lights, stairs, handrails, large instruments and process equipment, all to scale. The model is an accurate picture of the real plant in miniature.

The model is put together in the same chronological order as the real plant, foundations first, then supporting structures, then processing equipment, and finally piping. If a vessel will not fit in a structure or a pipe fails to go into place properly, the discrepancy discovered during model assembly and the construction forces avoid this problem in the field.

An accurate material takeoff can be obtained from a model with respect to pipe, fittings handrail, lights, etc.

Operator Training

The operating department takes over the model after the design and construction people are finished with it. They use it to train operators long before startup, and to prepare a job breakdown and labor standards. Shortest paths of travel are obvious in the model when they usually are not in drawings. Items that hinder startup, such as inaccessible valves, safety hazards, improper instrument location, can all be detected well in advance.

Operators can be trained faster with a color-coded model than in the actual plant. They can see relationship of equipment readily, and can trace pipe lines much faster than by walking through the actual plant.

Time-study men have used models to prepare labor standards prior to startup. This is a quicker and more accurate method than struggling through huge sheafs of drawings. In one plant, the use of a model to establish labor standards revised original estimates downward and thus offset its cost many times.

Maintenance

A model allows maintenance men to contribute to design, resulting in lowered maintenance costs. It is used later to plan repair jobs and expansions. Labor estimates and tool requirements may be obtained and instructions on proper execution of the job may be given in advance, so that the work can be carried out minimizing shutdown time.

Field Engineering

Men engaged in plant layout, proc-

(Continued on page 321)

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Sun's New Houdriflow Unit

by Paul D. Barton*

This article discusses the new catalytic cracking unit, completed last spring at the Toledo refinery of Sun Oil Co., which has been in operation for 9 months. Additional new facilities include a crude unit, vacuum feed-preparation unit, and gas-recovery unit. Operating results have been entirely satisfactory from the viewpoint of yields and quality of products. Several months of operation indicate that the maintenance problems will be at a minimum. Improvements to the catalyst gas-lift have brought the attrition losses within the expected economical values.

IN planning the major refinery addition completed in the spring of 1950, at Sun's Toledo refinery, it was necessary to integrate the design with the existing plant facilities. Among these facilities were a combination crude catalytic cracking plant, rated at 40,000 bbl. per stream day and comprising a crude and feed-preparation unit, a naphtha reformer, and a 12-case catalytic cracking unit of the fixed-bed type. The other units involved were thermal crackers, a polymerization plant processing a C_4 cut, and a stabilization and gas-recovery unit.

The fixed-bed-type cracking unit was built in 1938 simultaneously with a similar unit at Sun's Marcus Hook, Pa., refinery, and its design was based on experience gained from nearly 2 years' operation of the first commercial catalytic cracking unit for full-boiling-range gas oil, using a short time cycle and pressure regeneration of catalyst.

The existing catalytic section was limited to its designed coke-burning capacity, and to the inherent characteristics of the fixed-bed process in regard to sulfur contents of the charge, at 0.4 per cent maximum, and the boiling range of the charge, since it must be obtained in the vapor phase.

In planning the expansion the inclusion of increased catalytic cracking capacity was dictated by:

1. Production of a maximum economic yield of high-octane motor gasoline of one grade, with a minimum of seasonal demand products, such as kerosine, furnace oil, and heavy fuel oil, when charging pipeline crude.

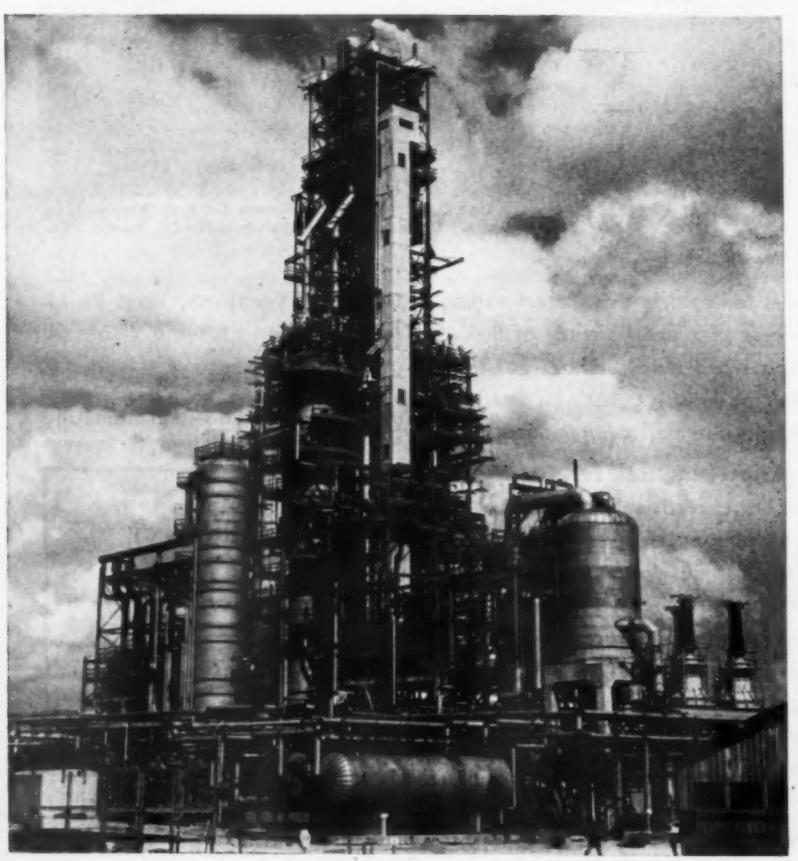
2. Production of at least 50 per cent yield of 10-lb. R.v.p., 83 to 84 clear research octane, based on crude.

3. Providing for the possibility of processing sour crudes, as well as the eventual production of aviation-gasoline components.

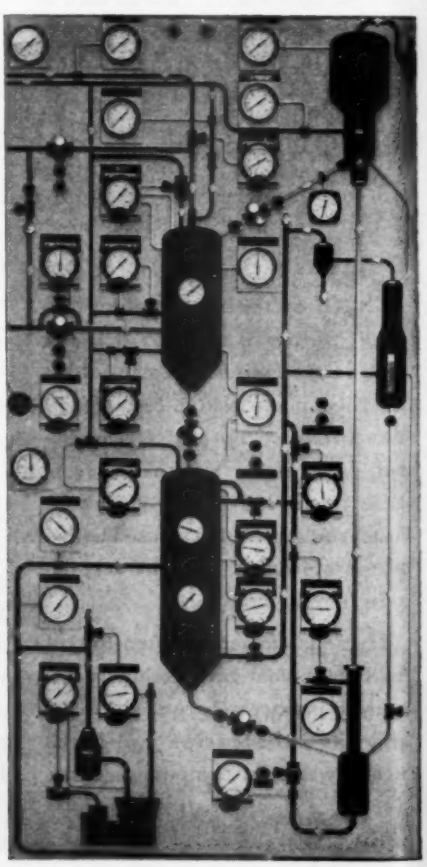
In view of the above considerations the over-all plant expansion was planned to include a combination crude - vacuum catalytic cracking plant. This plant was comprised of:

*Chief engineer, Sun Oil Co.

General view of the Houdriflow unit at Toledo. In foreground are synthetic crude tower, crude tower, vacuum tower, and catalytic cracking charge heaters.



One of four graphic panels controlling the Houdriflow unit at Sun's Toledo refinery.



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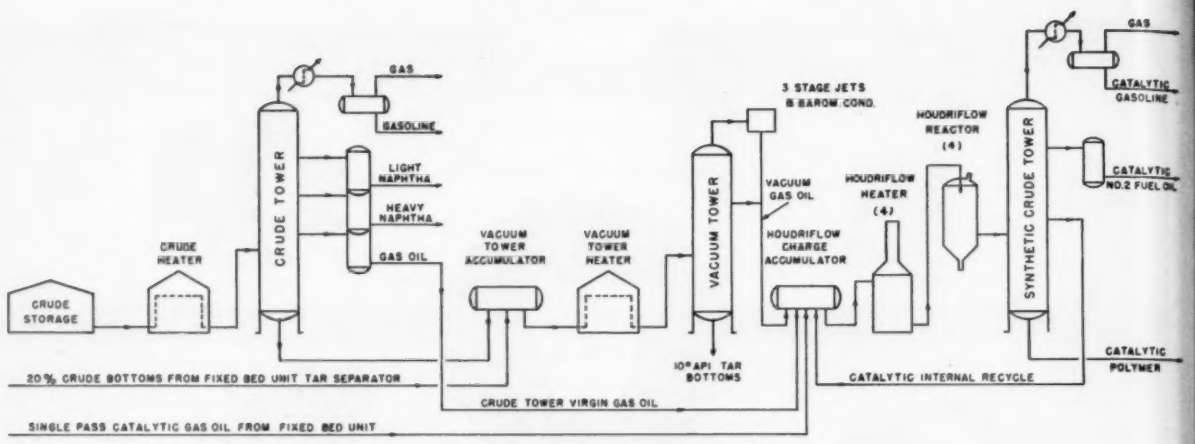


Fig. 1—Simplified flow diagram of crude and catalytic sections.

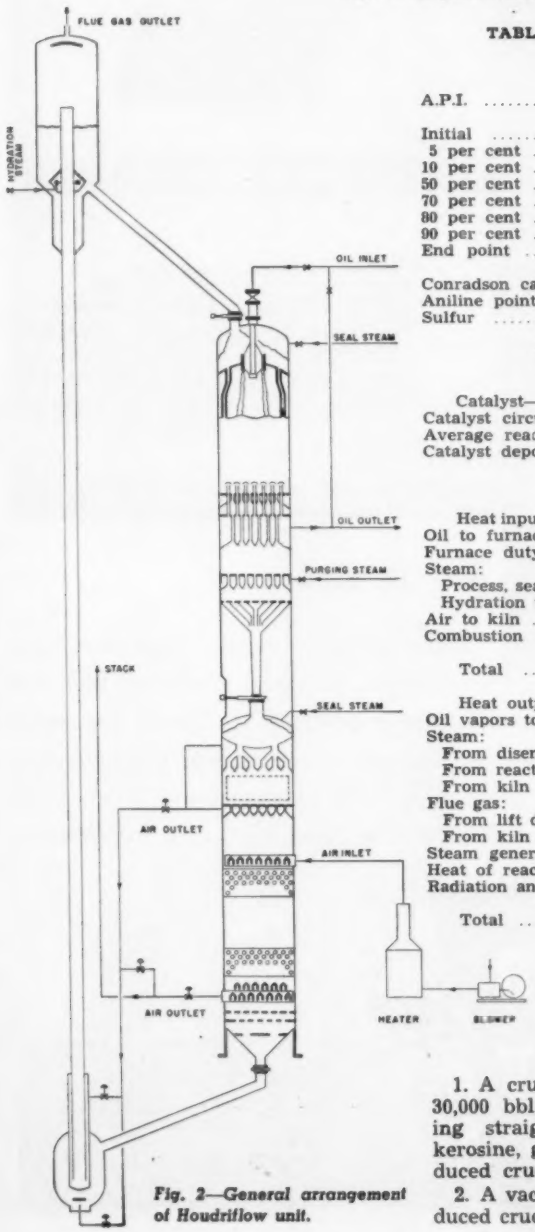


Fig. 2—General arrangement of Houdriflow unit.

TABLE 1—INSPECTIONS OF HOUDRIFLOW CHARGE COMPONENTS

	Crude	Gas oil—Virgin	Gas oil—Vacuum	Cracked gas oil—Light 80%	Cracked gas oil—Hvy. 20%
A.P.I.	38.4	32.8	23.7	32.6	31.6
Initial	....	496	743	424	450
5 per cent	161	536	829	488	541
10 per cent	222	561	840	494	553
50 per cent	560	660	919	522	593
70 per cent	700	....	....	539	611
80 per cent	724	....	....	550	621
90 per cent	....	760	1,061	568	636
End point	....	....	....	....	....
Conradson carbon	....	....	0.47	....	....
Aniline point	....	178.3	210.6	135	....
Sulfur	....	0.28	0.54	0.35	0.4

TABLE 2—HOUDRIFLOW UNIT DESIGN HEAT BALANCES
(Basis: 1 unit, reactor temperature for 92 F_2 clear octane)

Catalyst—	Clay	Bead
Catalyst circulation rate, tons/hr.	170	225
Average reactor temperature, °F.	920	890
Catalyst deposit, lb./hr.	3,250	3,000

Heat input—	Lb. per hour	Temp. (°F.)	Million B.t.u. per hour	Lb. por hour	Temp. (°F.)	Million B.t.u. per hour
Oil to furnace	90,075	500	30.45	90,075	500	30.45
Furnace duty	....	....	22.34	....	....	23.10
Steam:						
Process, seal, purge to reactor	8,770	....	10.39	7,650	....	9.07
Hydration to lift disengager	2,005	....	2.35	....	....	....
Air to kiln	44,900	150	1.68	40,000	150	1.50
Combustion	....	....	43.29	....	....	38.36
Total			110.50			102.48
Heat output—						
Oil vapors to synthetic tower	86,825	906	63.71	87,075	871	61.49
Steam:						
From disengager	800	1,017	1.23	800	1,005	1.23
From reactor	5,250	906	7.78	6,850	....	10.05
From kiln	4,725	939	7.13	....	....	....
Flue gas:						
From lift disengager	11,600	1,017	2.95	15,600	1,005	3.32
From kiln	36,550	981	9.24	27,400	944	6.93
Steam generation	....	....	9.97	....	....	10.50
Heat of reaction	....	....	5.89	....	....	6.06
Radiation and convection losses	....	....	2.60	....	....	2.30
Total			110.50			102.48

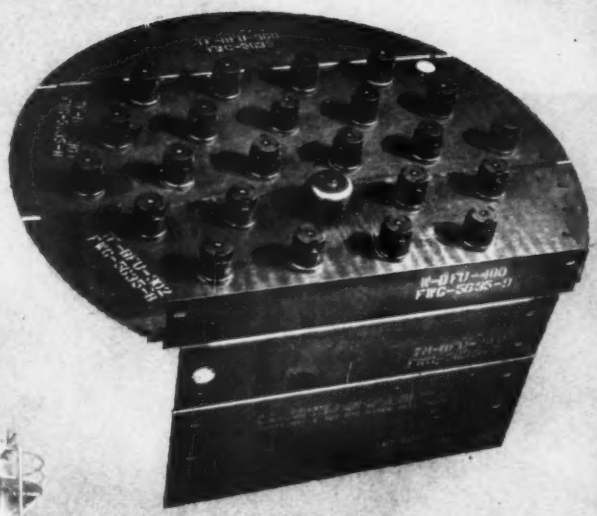
1. A crude unit—ultimate capacity 30,000 bbl. per stream day, producing straightrun gasoline, naphtha, kerosine, gas oil, and 30 per cent reduced crude.

2. A vacuum unit—charging the reduced crude from the new crude unit and the tar bottoms produced at the existing fixed-bed cracking unit tar separator, representing 20 per cent of the crude charged to this unit. Products to be overhead heavy gas oil suitable for catalytic cracking and bottoms of 10° A.P.I., representing 10 per cent of total crude to the refinery.

3. A catalytic cracking unit—charging the light gas oil from the crude

(Continued on page 322)

Glitsch FRACTIONATING EQUIPMENT



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Tide Water Associated Inaugurates

RADIO TRUCK CONTROL

Left: Labor Supervisor John Schrieder directs truck assignments through main transmitter station KEA 625 in his office. Right: Truck operator Eli Whaley reports from field to headquarters on completion of assignment.

by R. Beattie*

TIDE WATER ASSOCIATED OIL CO. recently installed a two-way radio communication system at its Bayonne, N. J., refinery which is maximizing the effective use of all its mobile units and enabling the supervisors to maintain closer contact with their manpower throughout the entire refinery and its outlying storage plant. Established under the direction of H. S. Chase, vice president in charge of manufacturing, the new refinery network has received ready acceptance by the operators licensed to use it.

The adoption of a plant-wide mechanization program 3 years ago first prompted the proposal that the refinery fleet of mobile units be controlled by direct radio communication *(The Oil and Gas Journal, July 16, 1948, page 70)*.

The company's initial experience in short-wave radio communication dates back over a year ago to January 1950, when two walkie-talkie F.M. sets were purchased for intercommunication between instrument men engaged in adjusting remote-control valves on cracking units structures. In this application the radio sets replaced the conventional method previously employed, where one instrument man was stationed in the control room and the other man up in the structure. This system required the use of either hand signals or a powerful voice and under these conditions adjustment of the instruments was lengthy and frequently inaccurate.

With the portable radios, it is now possible for one instrument man to stand directly in front of the control board and for the structure man to actually adjust the diaphragm motor valve on the spot with instant two-way communication available. Not only is considerable time saved but quality of the work has improved considerably.

Other Valuable Applications

While the management could foresee one or two other valuable applications it was found that once the various craftsmen in the refinery became familiar with operation of this equipment a great number of uses were automatically developed. For example, during the course of recent maintenance work it became necessary to install a three-phase electric power circuit on pole tops for a distance of 1,500 ft.

These conductors were 500,000 circular mil stranded cable. Tractive effort for the pulling in of this line was supplied by a small crawler-type bulldozer. Originally the job started by regulating activities of the tractor with hand signals which were relayed through two men. After the first day's work, it was suggested that the portable radios be used. This enabled the construction foreman, located at the cable-spool location, to communicate directly with the tractor operator and permitted the foreman to regulate very carefully the pull on the new cable.

Shortly thereafter, the two radio sets were used by two gangs of pipe fitters working 2,000 ft. apart on opposite sides of the refinery, engaged in locating and identifying a pipe line at the water front, which was being air pressured at the other end of the yard.

A third very important application was found in rigging operations, where the crane operator receives his instructions to raise, lower, or swing his boom in locations where he is not in direct line of vision with the foreman requesting the movements.

Multiple applications for these two portable radio sets, their dependability and clarity of reception, convinced Tide Water Associated engineers that short-wave radio communication could be successfully applied

*Technical assistant, manufacturing department, Tide Water Associated Oil Co.

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A Few of the Subjects Covered . .

- Design principles and applications for air-cooled and non-air-cooled mufflers.
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Two Tide Water 20,000-lb.-capacity radio-directed fork-lift trucks team up to handle transportation of 34,000-lb. electric generator.

to their truck and mobile equipment fleet. Accordingly, various manufacturers were interviewed and a final selection of equipment decided upon.

A choice had to be made not only between competitive equipment but also between purchased equipment and leased equipment. Several propositions were considered whereby instruments would be leased and maintenance applied on a monthly fee basis.

Considerable thought was given this phase of the investigation. After a survey of existing networks in a similar service had been made, the final conclusion was reached that maintenance of such equipment is not a problem. Engineering in this field is at present in an advanced stage of development as the result of military experience during World War II.

Once this basic question was settled the next step consisted of the installation of a test set in the proposed transmitting area and the use of the mobile set in one of the company passenger cars. A complete survey was made of all areas in the refinery where trucks or mobile equipment would be likely to operate. This survey revealed that transmission both ways was excellent and that no dead spots existed within the confines of the refinery area.

At this stage of the investigation it was decided that in order to secure maximum flexibility from the system, we should plan on intercommunication between the portable walkie-talkie units, and the mobile units in the trucks and field headquarters. Advantages accruing from crosscommunication would be numerous. It was anticipated that pipe fitters or other crafts, working on remote locations, would be able to report back to field headquarters to report completion of the job, unusual unforeseen circumstances, lack of material, and requests for transportation back to headquarters for reassignment. Further, it was felt that flexibility of the system could be multiplied by retaining a portable set in each zone headquarters, when not in field use, by means of which zone supervisors could monitor operations of trucks assigned to them, independently of the main dispatcher.

The proposed system included a monitor station in the office of the mechanical superintendent to permit his supervision of traffic when and if desired. It was also felt that the installation of this latter unit would supply an independent means of communication between the mechanical superintendent's office and field headquarters in the event of failure of the telephone system through fire or storm damage.

Because of the relatively heavy current demand placed on automotive battery systems by the radio equipment, it became necessary to install in each vehicle a Leece-Neville heavy-duty generator. The capacity of these generators is such that sufficient current is generated at idling engine speed to prevent any drain on the battery as a result of standby load, which amounts to about 6 amp.

Initial Network

After all engineering and planning preliminaries had been completed, the sets were ordered, delivered, and installation of the following units was started.

1. Main transmitting station—15 watts.

2. Ten mobile units installed in protection department, patrol car, trucks, fork lifts, and a Ross straddle-type carrier.

3. A remote-control-type station for use in the telephone switchboard room to establish communication between the night telephone operator and the patrol car on a round-the-clock basis.

4. A monitor station installed in the office of the mechanical superintendent.

5. Two walkie-talkie units tuned to frequency of the mobile network.

Facilities were provided by erecting an 85-ft. telephone pole with a 15-ft. extension of 2-in. aluminum tubing to support the isotope antenna.

A number of regulations of the Federal Communications Commission have to be compiled with before operations of such a system is permitted. These include licensing of the station, assignment of frequency, licensing of operators for third-class operations, check of frequency by a licensed FCC radio technician and, lastly, a 48-hour notice to the FCC of intention to operate. With these details disposed of, station KEA 625 and mobile stations group KA 4281 opened for business January 16, 1951, operating on a frequency of 153.17 megacycles.

A week prior to the operation date operators were assembled for hourly briefing on the adjustments, methods of operation, FCC regulations, and the peculiar language used by short-wave-radio operators. Consequently, while there was some confusion during the first day's operation arising principally from "mike fright," on the whole, the licensed operators rapidly adjusted themselves to the new operation and by the end of the week were thumbing the mike button and saying "roger," "over," and "out" like veterans.

Any previous doubts that existed on the ability of the operators quickly to grasp the principles of operation were dispelled after the first 8 hours on the air. A record of the second day's traffic load between 9:30 a.m. and 11:30 a.m. showed a call frequency of approximately 6 minutes.

Results of Investment

A review of the station log book readily reveals what will be accomplished by the investment. A few excerpts are presented for evaluation.

1. "Truck No. 2 left Bayonne for Brooklyn 9:00 a.m. contacted at entrance to Holland Tunnel and ordered to proceed to Long Island City for another pickup, which was not contemplated when the truck left the refinery. Driver reported in second pickup, time of departure and expected arrival time at Bayonne."

In this case the system was able to instruct a truck driver to proceed for the second pickup and thus saved a complete round trip from Bayonne to Long Island City.

2. "Truck A left material warehouse for yard deliveries. Contacted at 1-R unit and told to pick up bundle of files at main office, thus saving approximately 1 hour.

3. "Ross Fork 10-ton lift truck No. 1 was sent to waterfront to pull old pipe line from ditch.

4. "Ross Fork lift truck No. 1 called to report labor department on completion of job. Reassigned to yard 6."

This is an excellent example of prompt dispatch of vital equipment.

5. "Pipe fitters called in by telephone to report completion of job and request transportation from yard No. 6 to waterfront."

Transportation of these men by truck from job to job, which previously could not have been accomplished, saved the time of six mechanics, by the difference between walking across refinery and riding in the truck.

(Continued on page 327)

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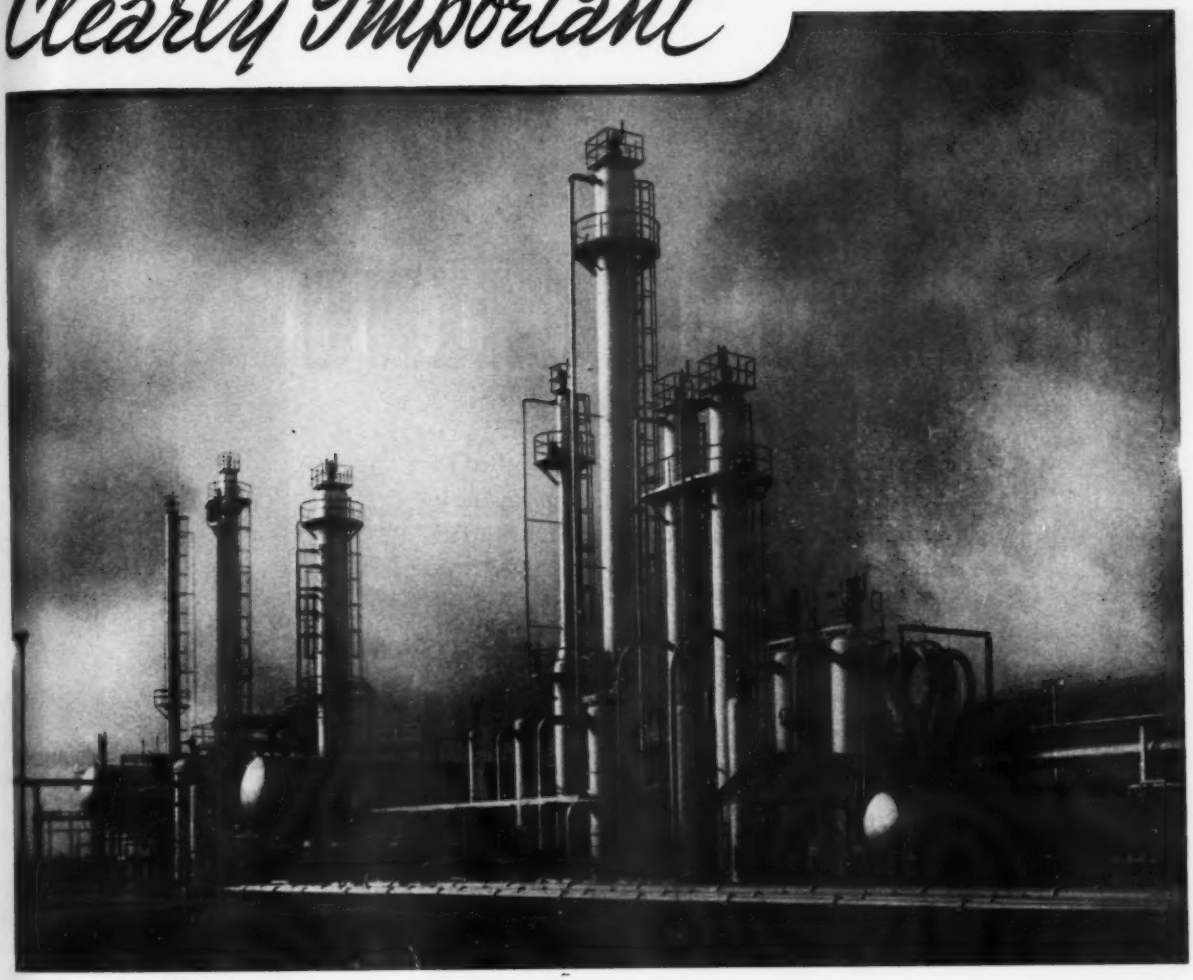

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High Destruction Thermal Cracking

of Catalytic Cycle Oil

by D. M. Little* and G. E. Merryfield*

THE unprecedented demand for high-octane gasoline has given impetus to the increase in catalytic cracking capacity throughout the country. Because they are capable of producing higher yields of premium quality gasoline and distillates with lower yields of residual fuel oil, catalytic crackers are justifiably replacing thermal cracking units for the conversion of virgin stocks boiling above 400° F. to gasoline and distillates. Thermal cracking units have generally been relegated to the role of cracking cycle oil from catalytic cracking units.

The utilization of existing cracking units designed for thermal cracking of virgin stocks does not usually lend itself to the most efficient handling of refractory cycle oils. Thermal cracking units are usually operated at reduced capacity when cracking cycle oil because the high crack per pass attained on virgin gas-oil cannot be reached on the cracked cycle oil without either excessive coil coking or exceeding furnace design temperatures.

To determine the best cracking conditions for thermal cracking of catalytic cycle oil, an extensive series of pilot-plant tests was made. Tests included single-pass, two-pass, and recycle cracking at pressures of 750 and 1,500 psig. This article presents the results and interpretation of pilot-plant tests which led to the selection of a specially designed radiant heater for commercial cracking of catalytic cycle oil at a high crack per pass. A comparison is shown of commercial cycle-oil cracking on the new radiant heater and on a thermal cracking furnace designed and constructed in 1933.

Pilot-Plant Operation

A total of 38 pilot-plant runs were made to evaluate thermal cracking of catalytic cycle oil at single-pass, two-pass, and recycle cracking and at pressures of 750 and 1,500 psig. Pilot-plant cracking resulted in the following conclusions:

1. In thermal cracking of catalytic cycle oil, aniline-point reduction and conversion of gas-oil correlate very well.

2. For the same aniline-point reduction of gas oil, once-through cracking produces more dry gas, total butanes, and fuel oil, and less gasoline at 750 than at 1,500 psig.

3. For the same aniline-point reduction of gas-oil, higher-octane gasoline is produced at 750 than at 1,500 psig., but for a given charge rate and coil capacity much higher cracking temperatures are required to obtain the same aniline-point reduction at the lower pressure.

4. For a given charge rate and coil capacity, more gasoline and more barrel octanes will be obtained at operable temperatures at 1,500 than at 750 psig.

5. Highest octane ratings can be obtained by once-through cracking in heaters with the shortest residence time.

6. For the same gas-oil, aniline-point reduction, recycle cracking produces more gasoline but less gas-oil and lower octane ratings than once-through cracking.

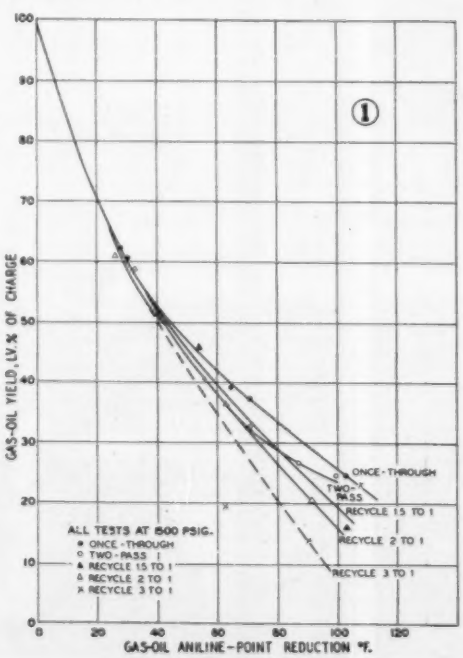
7. For the same gas-oil, aniline-point reduction, two-pass cracking produces more gasoline but lower octane rating than two to one recycle cracking.

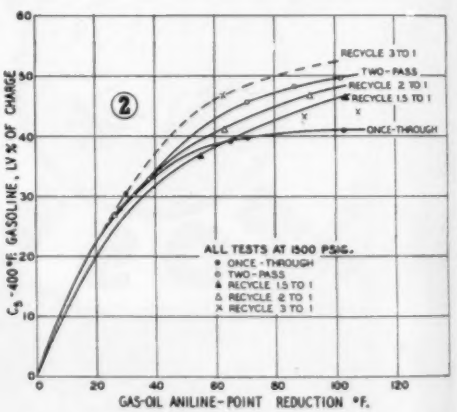
The use of aniline-point reduction as a correlating parameter may seem unusual to those who are accustomed to using "K" factors, degrees A.P.I. gravity, or C_3 and lighter. However, as gas-oil is cracked and becomes degraded, the gas-oil fraction becomes

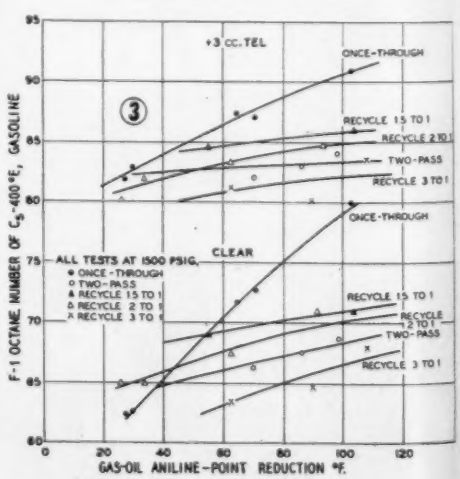
Fig. 1—Gas-oil yield vs. aniline-point reduction. Pilot-plant cracking.

Fig. 2—Gasoline yield vs. gas-oil aniline-point reduction. Pilot-plant cracking.

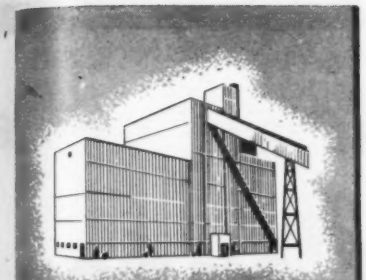
Fig. 3—Gasoline octane number vs. gas-oil aniline-point reduction. Pilot-plant cracking.







*Phillips Petroleum Co. Bartlesville, Okla.



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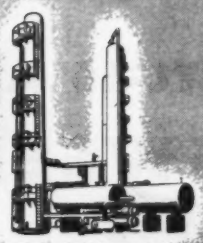

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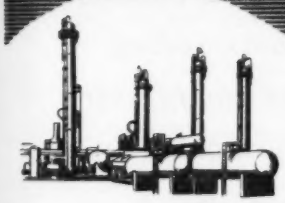

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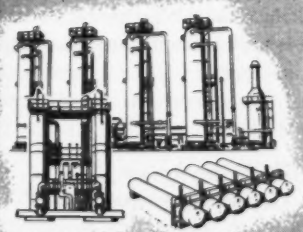

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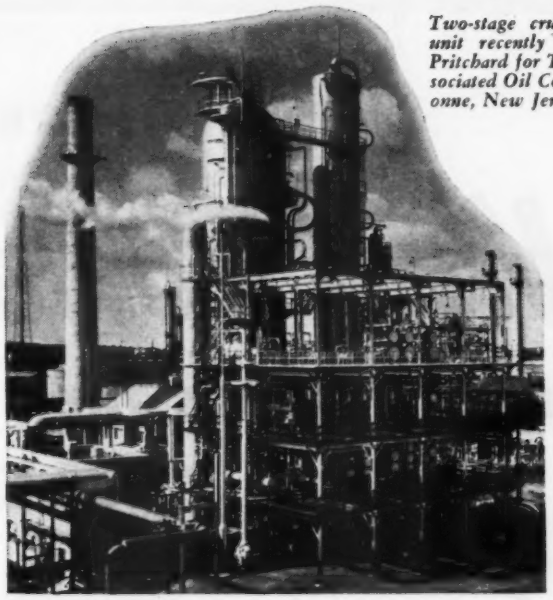

Two-stage crude distillation unit recently completed by Pritchard for Tide Water Associated Oil Company at Bayonne, New Jersey.

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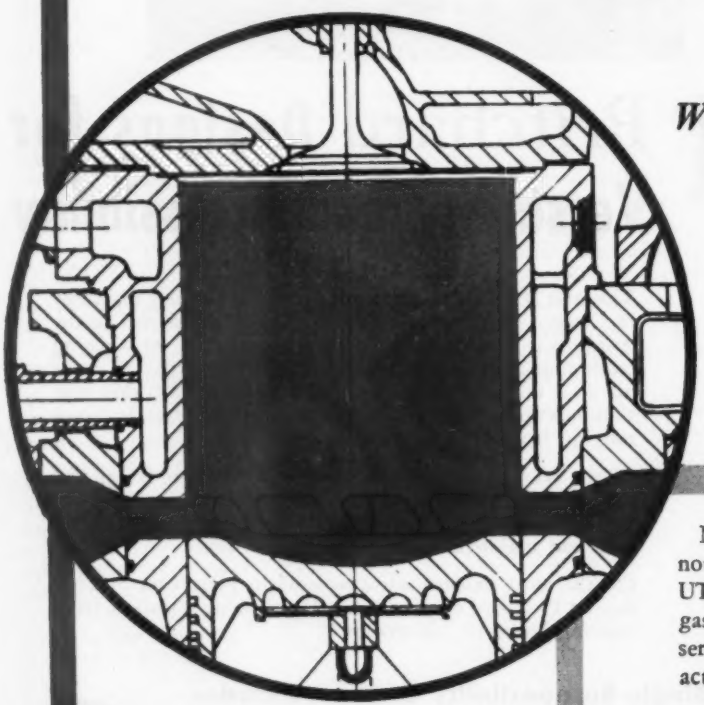

Worthington's timed scavenging system proves a valuable aid to outstanding gas engine compressor performance

ESSENTIAL FEATURES: complete removal of exhaust gas . . . more thorough charging with gas and air . . . positive timing for optimum combustion . . . effective supercharging, low operating temperature prevents carbonization . . . uniform cylinder temperature results in equal wall stress eliminating harmful stresses.

RESULTS: less down-time . . . lower-cost maintenance . . . higher efficiency.

Nothing in recent years has attracted as much notice as the quick success of Worthington's uniflo UTC-16. For, here is peak economy and efficiency in gas transmission and many petroleum processing services — proved by exhaustive testing under actual working conditions.

Uniflo Scavenging . . . A Truly Great Improvement

A major factor in the UTC-16's outstanding performance is the Worthington uniflo scavenging principle. Concentrated in the *Vital Power Center* — see illustration — the uniflo method assures a thorough-going "clean sweep" resulting in many bene-

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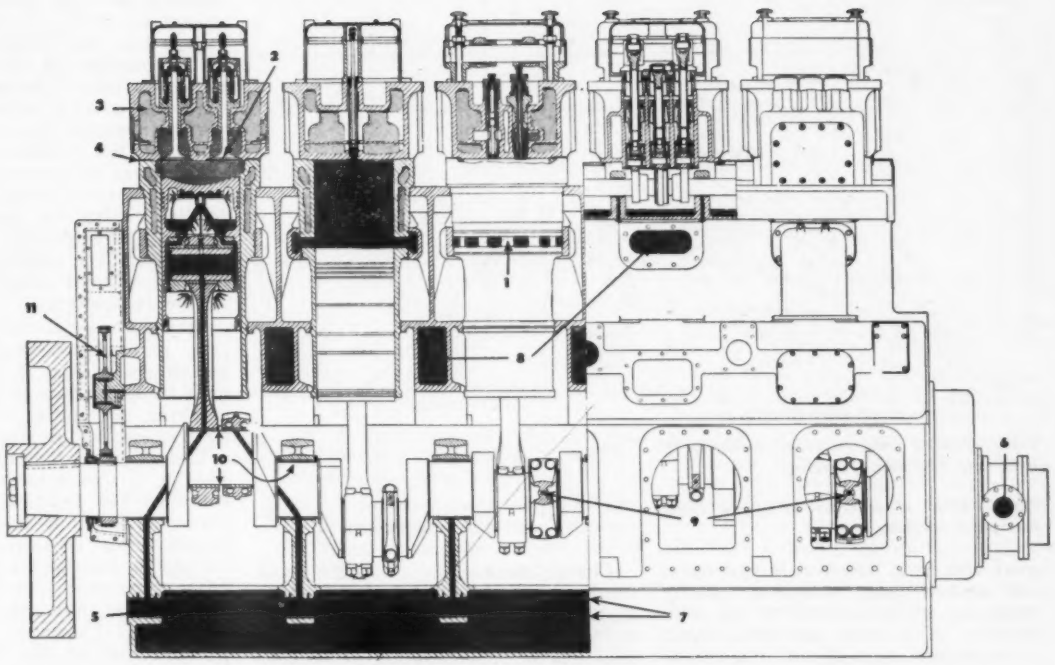

Advanced Features Of The UTC-16

1 360° inlet ports with directional flow.

2 Large exhaust valves. Cam-operated — positive timing — extra large exhaust passages.

3 Cylinder head cooling. Large passages — water carefully directed for uniform cooling.

4 Metal-to-metal joints. Cylinder heads seat on liners — no gaskets.

5 Positive lubrication. Entire running gear pressure lubricated.

6 Lube oil pump. Low speed direct connected . . . readily accessible.

7 Cast-in lubricating oil manifolds. Jointless — no internal connections — large sump.

8 Large scavenging air supply. Multiple air pumps — reciprocating type two scavenging reservoirs one on each side of engine — large elbows from reservoirs to ports.

9 Well-spaced compressor cylinders. Complete accessibility of cylinders and crossheads — permits use of large cylinders.

10 Large bearing area. Low unit pressure . . . cool running . . . long life . . . four studded bearing caps . . . precision-type bearing shells.

11 Gear driven camshaft. Positive, quiet operation.

fits for smoother operation. It is the first time this type of scavenging has been adapted to engine compressor duty and its incorporation with the advanced over-all UTC-16 design marks the beginning of a new era in lower-cost, more dependable performance.

Versatility

While designed primarily as a pipeline gas engine compressor, the UTC-16 is suitable for many other services, including: pressure maintenance on oil wells . . . in natural gasoline plants . . . in oil refineries, for solvent extraction, vapor recovery, recycling and stabilization of gases . . . in petrochemical processing of products made from natural gas under pressure . . . in many refrigeration applications.

The uniflo UTC-16 is built in sizes ranging from 800 to 2,000 hp. If you have a process where gas must be compressed, and a suitable gas fuel is available, make a point of investigating this outstanding angle gas engine compressor. For further proof that *there's more worth in Worthington*, contact our nearest Branch Office, or write the *Worthington Pump and Machinery Corporation, Engine Sales Div., Buffalo, N. Y.*

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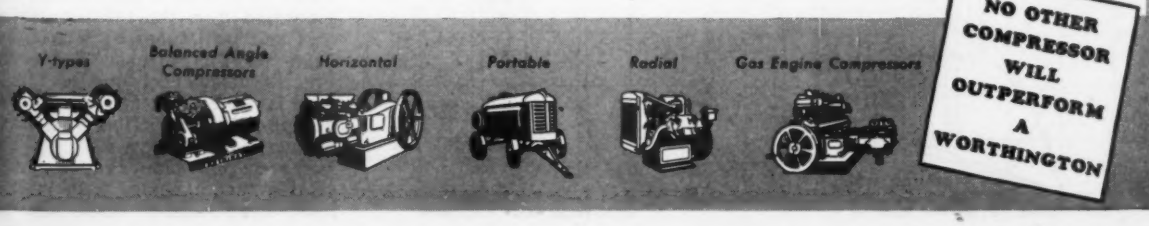


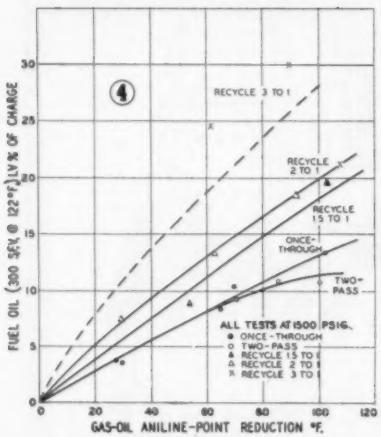


Fig. 4—Fuel-oil yield vs. gas-oil aniline-point reduction. Pilot-plant cracking.

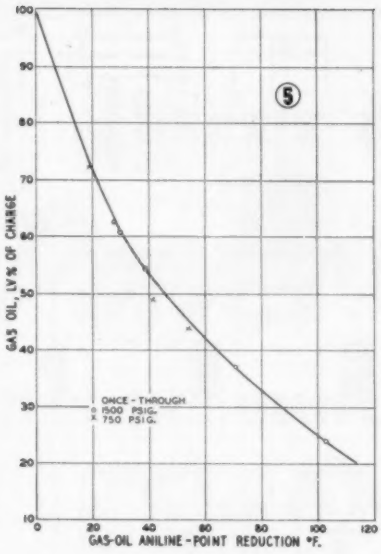


Fig. 5—Effect of pressure on gas-oil yield. Pilot-plant cracking.

more and more deficient in hydrogen, and aniline point which is usually taken as an indication of the aromaticity of a stock has been found to correlate very well with the cracking yields if the boiling range of the gas oil is not appreciably changed.

In addition to being a simple and rapid test to run, aniline point is quite often an important specification of aromatic oils supplied for special uses. It is sometimes desirable to crack cycle oil to a definite aniline-point, gas-oil yield. The gas-oil yield from cycle-oil cracking as used in this paper is defined as the fraction boiling between 400° F. end-point gasoline and fuel oil of a viscosity of 300 S.F.S. at 122° F. since the refinery under consideration marketed all of its residual oil as No. 6 grade fuel oil. The gas-oil yield generally had an A.S.T.M. initial boiling point of 400° F. to 440° F. and an end point of 650° F. to 700° F.

Charge stock.—The charge stock used in the pilot-plant tests was 156° F. aniline-point, light cycle oil from a "Cycloversion"* catalytic cracking unit which was operating at 53 L.V. per cent conversion on a charge of 180° F. aniline-point, Texas Panhandle virgin gas oil. It has generally been observed that catalytic crackers operating at about 50 L.V. per cent conversion on a 180° F. to 200° F. aniline point charge will yield a light cycle oil of 150° to 160° F. aniline point. The characteristics of the pilot-plant charge are shown in Table 2. Very few data were obtained on the effect of charge-stock characteristics on yields except that for the two-pass operation the 118° F. aniline-point, gas oil from the first pass was stored and cracked again on a second pass.

Process considerations.—The average operating conditions for once-through cracking and the product distribution and characteristics are shown in Tables 3, 4, and 5. The charge rate was maintained substantially constant for all tests, and furnace-coil outlet temperatures were varied to cover a wide range of conversion. Operating pressure was regulated at the expansion valve. Coil coking was experienced in the tests at more severe conditions and transfer-line coking was troublesome, particularly downstream of the expansion valve. The results reported here are coil effluent samples fractionated in the laboratory.

Correlation of yields of gas oil, gasoline, gasoline quality, and fuel oil are shown in Figs. 1, 2, 3, and 4 for once-through, two-pass, and recycle cracking. All operations are at 1,500-psig. operating pressure.

The effect of pressure is shown in Figs. 5, 6, and 7 for operating pressures of 750 and 1,500 psig. These curves show that the unleaded research octane (F-1) number is 6.5 to 7.0 higher and leaded (3 cc.) octanes 2.5 to 3 numbers higher for the same aniline-point reduction at 750 than at 1,500 psig. However, it should be realized that at the lower pressure much higher coil temperatures are required for the same aniline-point reduction because of shorter residence time and coil coking may be a limiting factor. This means that for a given coil capacity, greatest gasoline yield and most barrel octanes will be obtained by operating at the higher pressure.

Pilot-plant equipment.—The furnace-coil arrangement for these tests is shown in Fig. 10. This was a radiant-type furnace with 24 convection and 24 radiant tubes. All tubes were 1.315 in. o.d. by 0.815 in. i.d. and approximately 11 ft. long. The flow was straight down through the convection and radiant coils. The furnace operated at a low per cent excess air and high radiant-heat input rates. With this coil arrangement it was possible to reach high outlet temperatures with a short residence time. The furnace effluent was quenched with gas-oil upstream of the expansion valve which released the pressure into the fractionator.

*A service mark and trade mark.

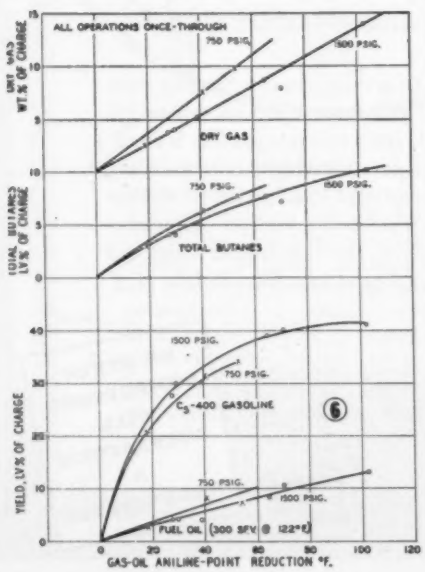


Fig. 6—Effect of pressure on dry gas, total butanes, gasoline, and fuel-oil yields. Pilot-plant cracking.

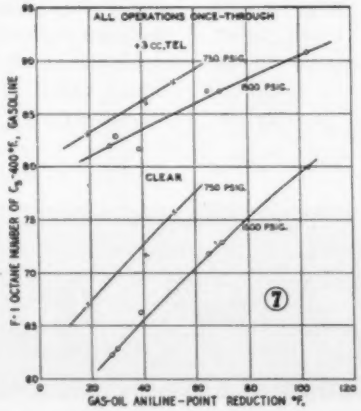
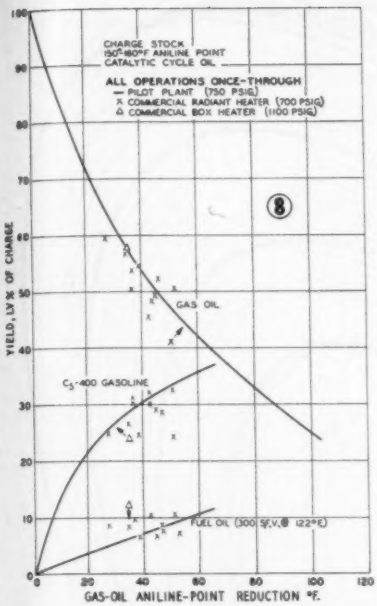


Fig. 7—Pilot-plant cracking effect of pressure on gasoline octane number.

Commercial Cycle-Oil Cracking

Commercial cracking of catalytic cycle oil was also being tried at the time the pilot-plant tests were made. The charge stock was substantially the same as the pilot-plant charge (Table 2). However, the commercial furnace was a box heater designed about 1933 with a convection section separated from the radiant section of roof and wall tubes by a bridgewall. Flow on this furnace is shown in Fig. 12. Residence time in this furnace is rather high and the maximum aniline-point reduction without excessive coil coking was 30° to 35° F. However, pilot-plant cracking had indicated that a heater with high uniform heat-transfer rates and short



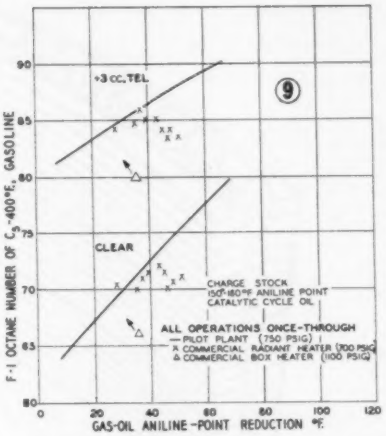


Fig. 8—Comparison of pilot-plant and commercial cycle-oil cracking. Yield vs. gas-oil aniline-point reduction.

Fig. 9—Gasoline octane number vs. gas-oil aniline-point reduction. Comparison of pilot-plant and commercial cycle-oil cracking.

residence time would be desirable for high destruction thermal cracking of cycle oil. An updraft radiant-type heater with these heating characteristics had been designed and constructed specifically for vis-breaking high-vacuum residuums and this heater was easily adapted to cycle-oil cracking. Flow on this heater is shown in Fig. 11. A heater similar in design had previously been suggested for refinery heaters.[1]

The construction, operation, and performance of the vis-breaking heater will be discussed in detail at the Western Petroleum Refiners Association annual meeting, April 1-3, 1951, at San Angelo. The utilization of this heater for vis-breaking of a high-vacuum residuum will be discussed in a paper to be presented at the Midwest regional meeting of the American Institute of Chemical Engineers at Kansas City, Mo., May 13-16, 1951.

Process considerations. — The new radiant furnace operated successfully on commercial cycle-oil cracking, and aniline-point reduction as high as 50° F. was obtained without serious coil coking. Table 1 shows a comparison of pilot-plant, radiant furnace, and box-furnace once-through cycle-oil cracking.

TABLE 1

	Pilot plant	Commercial: Radiant furnace	Commercial: Box furnace
Coil outlet temp., °F.	....	1,025	920
Pressure, psig.	750	700	1,100
Charge rate, bbl. per hour	6.3	100	300
Aniline-point reduction, °F.	50	50	35
Yields, L.V. per cent of charge:			
Gasoline	33	30	22
Gas oil	44	44	57
Fuel oil (300 S.F.V. at 122° F.)	8.5	10	12
Gasoline quality:			
F-1 clear	75	73	66
+3 cc.	87.5	86	80

This table shows the effectiveness of the radiant furnace in increasing cracking severity and improvement of gasoline octane ratings over the old-type box furnace. Commercial operation with the radiant furnace also closely approximated pilot-plant tests as shown in Figs. 8 and 9. The lines on Figs. 8 and 9 represent the pilot-plant correlation and the points represent commercial data. One point is shown for the box-furnace commercial operation.

Summary

High-destruction thermal cracking of catalytic cycle-oil has been

TABLE 2—PILOT-PLANT CHARACTERISTICS OF CHARGE STOCK

A.S.T.M. distillation:	
I.b.p., °F.	436
5 per cent	480
10 per cent	499
20 per cent	513
30 per cent	528
40 per cent	543
50 per cent	559
60 per cent	574
70 per cent	592
80 per cent	602
90 per cent	640
95 per cent	664
End point	669
Recovery	97.0
Residue	3.0
Gravity, °A.P.I.	33.9
Aniline point, °F.	156
Total sulfur, wt. per cent	0.163
Carbon residue, wt. per cent	0.031
Pour point	+30
S.U.V. at 100° F.	39.6

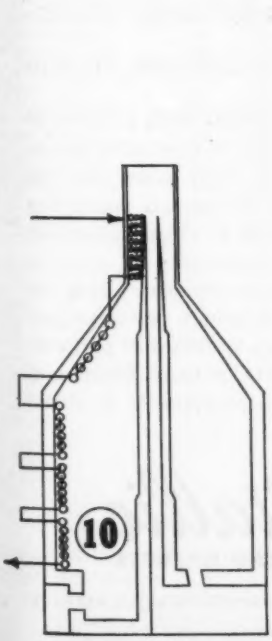


Fig. 10—Pilot-plant heater.

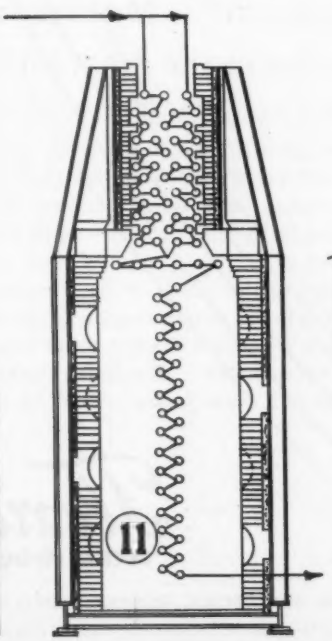


Fig. 11—Commercial radiant heater.

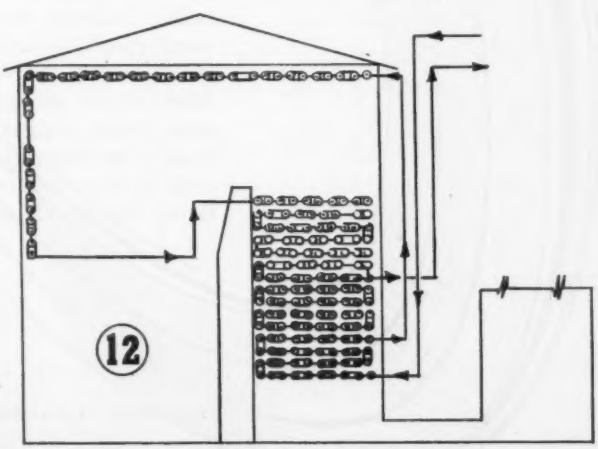


Fig. 12—Commercial box heater.

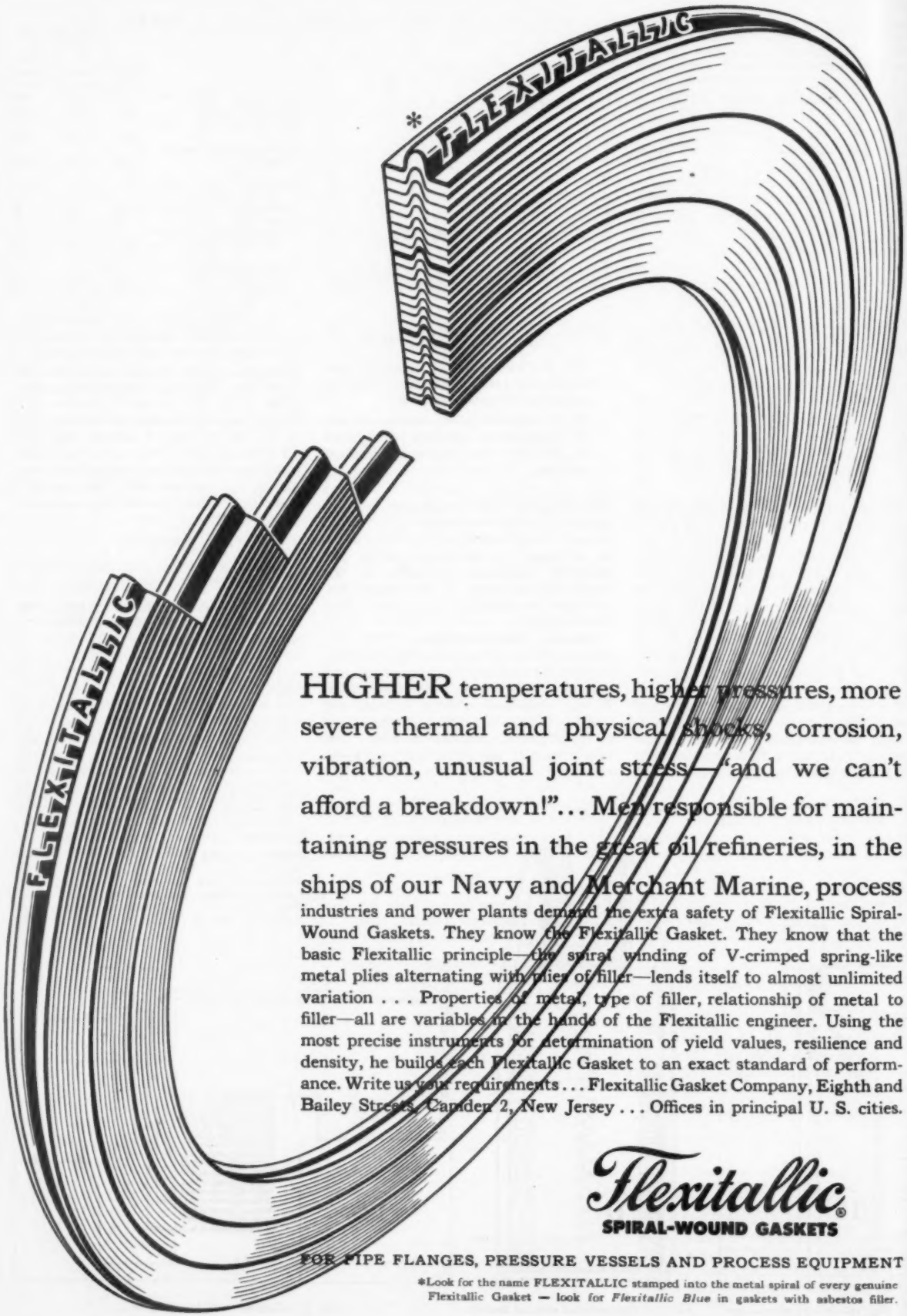


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TABLE 3—PILOT-PLANT OPERATING CONDITIONS

Test No.—	Group 1-A—1,500 psig.						Group 1-B—750 psig.		
	73-6-1	MB No. 5	73-3-1	73-5-1	73-2-1	73-4-1	73-10-1	73-11-1	73-26-1
Charge rate, bbl. per hour	6.27	6.24	6.89	5.72	6.44	6.94	5.96	5.90	6.27
Furnace coil temperatures, °F.:									
Coil inlet	132	122	101	96	85	107	104	110	102
Roof tube inlet	586	580	594	629	615	669	594	625	686
Roof tube outlet	759	756	768	829	806	867	775	840	878
36th tube outlet	865	863	881	942	929	965	885	945	969
42nd tube outlet	943	944	960	986	991	1,018	952	998	1,025
48th tube (coil outlet)	955	952	983	1,026	1,012	1,062	967	1,032	*958
Furnace pressures, psig.:									
Coil inlet	1,530	1,545	1,570	1,580	1,570	1,590	810	810	810
Coil outlet	1,520	1,530	1,530	1,510	1,540	1,525	785	795	770
Expansion valve	1,500	1,505	1,510	1,470	1,500	1,510	760	750	635

*Coked.

TABLE 4—PILOT-PLANT PRODUCT DISTRIBUTION

Test No.—	Group IA—1,500 psig.										Group IB—750 psig.					
	73-6-1		73-3-1		73-5-1		73-2-1		73-4-1		73-10-1		73-11-1		73-26-1	
Yields, % of charge:	Wt. %	LV %	Wt. %	LV %	Wt. %	LV %	Wt. %	LV %	Wt. %	LV %	Wt. %	LV %	Wt. %	LV %	Wt. %	LV %
Hydrogen	0.01	.....	0.01	.....	0.02	.....	0.02	.....	0.04	.....	0.01	.....	0.02	.....	0.02	.....
Methane	0.66	2.28	0.95	3.29	1.52	5.26	1.55	5.36	2.89	10.00	0.40	1.38	1.15	3.98	1.48	5.12
Ethylene	0.16	0.35	0.13	0.29	0.31	0.69	0.37	0.82	0.65	1.44	0.19	0.42	0.67	1.48	0.82	1.81
Ethane	0.91	2.07	0.95	2.16	1.84	4.18	2.17	4.93	3.53	8.01	0.60	1.36	1.64	3.72	2.10	4.77
Propylene	0.76	1.25	0.73	1.20	1.38	2.26	1.62	2.66	2.40	3.94	0.65	1.07	1.93	3.17	2.26	3.71
Propane	1.47	2.47	1.25	2.10	2.76	4.64	3.11	5.22	4.56	7.66	0.97	1.63	2.30	3.86	3.08	5.17
Butylene	1.10	1.56	1.12	1.58	2.03	2.88	2.23	3.16	2.89	4.09	0.94	1.33	2.33	3.30	2.88	4.08
Butane	1.77	2.61	1.77	2.61	2.95	4.34	3.14	4.62	4.19	6.17	1.20	1.77	2.13	3.14	2.46	3.63
C_5-400° gasoline	24.29	27.91	26.28	30.15	34.82	39.90	34.06	39.09	35.80	40.85	18.22	21.03	27.29	31.51	29.51	34.01
Gas oil	64.18	62.35	62.40	60.74	39.60	37.16	41.43	39.07	25.59	24.22	73.63	72.38	51.03	49.06	46.58	44.43
Fuel oil	4.69	3.97	4.41	3.81	12.77	10.45	10.30	8.43	17.46	13.33	3.19	2.71	9.51	8.10	8.81	7.31
Total	100.00	106.82	100.00	107.93	100.00	111.76	100.00	113.36	100.00	119.71	100.00	105.08	100.00	111.32	100.00	114.04
Conversion, % of charge:																
100—Gas oil	35.82	37.65	37.60	39.26	60.40	62.84	58.57	60.93	74.41	75.78	26.37	27.62	48.97	50.94	53.42	55.57
100—(Gas oil + fuel oil)	31.13	33.68	33.19	35.45	47.63	52.39	48.27	52.50	56.95	62.45	23.18	24.90	39.46	42.84	44.61	48.36
Product characteristics:																
Gasoline Oct., C.F.R.R. clear	62.3	.....	62.6	.....	72.7	.....	71.8	.....	80.0	.....	67.0	.....	71.6	.....	75.7	.....
+3cc. TEL	81.9	.....	82.8	.....	87.0	.....	87.3	.....	90.8	.....	83.1	.....	86.3	.....	88.0	.....
Gas-oil aniline pt., °F.	128.0	.....	126	.....	85.6	.....	91.0	.....	53.0	.....	137.2	.....	114.3	.....	101.9	.....

TABLE 5—PILOT PLANT CHARACTERISTICS OF PRODUCTS

Test No.—	Group IA—1,500 psig.										Group IB—750 psig.					
	73-6-1		73-3-1		73-5-1		73-2-1		73-4-1		73-10-1		73-11-1		73-26-1	
	BF-400		BF-400		BF-400		BF-400		BF-400		BF-400		BF-400		BF-400	
A.S.T.M. distillation:	Gaso.	Gas oil	Gaso.	Gas oil	Gaso.	Gas oil	Gaso.	Gas oil	Gaso.	Gas oil	Gaso.	Gas oil	Gaso.	Gas oil	Gaso.	Gas oil
I.b.p.	109	445	108	446	108	456	105	No	101	410	106	448	110	445	111	443
5 per cent	142	480	140	480	137	460	135	distil-	134	439	140	472	139	464	137	461
10 per cent	156	486	158	489	151	467	150	lation	146	450	155	492	152	474	150	471
20 per cent	182	500	186	498	172	480	173	....	166	464	181	501	173	489	168	483
30 per cent	212	514	216	512	194	490	198	....	187	472	209	514	195	500	189	501
40 per cent	241	527	246	525	220	500	227	....	212	483	238	529	220	515	214	514
50 per cent	259	541	276	540	247	513	254	....	239	506	266	544	247	530	241	525
60 per cent	296	559	302	555	274	530	281	....	287	515	293	559	275	546	270	539
70 per cent	322	580	326	568	301	553	309	....	297	534	316	576	302	566	297	555
80 per cent	347	608	351	582	330	580	330	....	329	560	342	593	327	577	328	581
90 per cent	372	646	376	606	363	621	367	....	361	595	365	635	359	629	357	610
E.p.	400	711	401	613	404	684	398	....	400	642	402	650	398	691	404	688
Rec. per cent	98.0	97.0	98.0	99.0	98.0	98.5	98.0	....	98.0	96.5	98.5	94.0	98.5	97.0	99.0	98.0
Res. per cent	1.0	3.0	1.0	1.0	0.5	1.5	1.0	....	1.0	3.5	0.5	6.0	0.5	3.0	0.5	1.0
Gravity, °A.P.I.	58.5	29.2	58.2	29.5	58.0	24.0	58.3	24.5	57.2	21.5	59.4	31.1	59.4	27.5	59.1	26.3
R.v.p.	5.2	....	5.4	....	5.4	....	5.7	....	5.2	....	5.7	....	5.4	....	5.8	....
Bromine No.	54	....	64	....	59	....	59	....	68	....	72	....	67	....	74	....
Aniline pt., °F.	105.5	128.0	104.0	126	94.0	85.6	96.0	91.0	88.0	53.0	101.5	137.2	94.4	114.3	86.6	101.9
Total sulfur, wt. %	0.028	....	0.019	....	0.021	....	0.016	....	0.016	....	0.024	....	0.016	....	0.018	....
Gasoline octane No.:																
C.F.R.R., clear	62.3	....	62.6	....	72.7	....	71.8	....	80.0	....	67.0	....	71.6	....	75.7	....
+3cc. TEL	81.9	....	82.8	....	87.0	....	87.3	....	90.8	....	83.1	....	86.3	....	88.0	....
C.F.R.M.	58.2	....	58.5	....	66.7	....	65.0	....	70.2	....	60.4	....	63.9	....	66.2	....
+3cc. TEL	75.3	....	74.2	....	78.4	....	78.8	....	81.0	....	74.5	....	76.6	....	78.4	....
Fuel oil:																
Gravity, °A.P.I.	9.6		6.0		3.9		3.9		0.1		9.9		8.3		5.8	
S.f.v. at 122° F.	317		300		273		291		300		328		233		275	

achieved both on pilot-plant and commercial equipment. Successful cracking of cycle oil at high crack per pass requires a radiant-type heater with high uniform heat-transfer rates and short residence time. Aniline-point reduction of the gas-oil charge correlates very well with conversion and yields. Highest octane ratings are obtained on once-through operation at low pressure. For the same aniline-point reduction of gas-oil, higher gasoline yields are obtained by recycle cracking than once-through, but octane ratings are lower.

Reference

1. Mekler, L. A., and Von Fredersdorf, C. G., Petroleum Refiner.

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In this aerial view of refining and related operations near Lake Charles are shown: A—Cit-Con's lube-oil plant; B—Copolymer plant operated by Firestone; C—Butadiene plant operated by Cities Service, and D—The basic refinery of Cities Service.

Supply and Distribution of Utilities At Cit-Con's Lubricating-Oil Plant

by Andrew Sherman*

Utilities have given excellent service and should continue to do so, even when the oil and wax-processing units are operating at substantially greater than design rates that are anticipated for 1951

CIT-CON OIL CORP.'S lubricating-oil plant completed its first full year of operation in 1950. Average production was slightly above design. With startup problems eliminated, it is now estimated that 1951 production will be even greater, which should materially help the petroleum industry in meeting an increase in both military and civilian demands for lubricating oils and waxes.

Briefly, Cit-Con operations include vacuum distillation which separates the reduced-crude charge into fractions which will yield lubricating oil varying from low-viscosity neutrals to heavy bright stock; solvent extraction which removes undesirable components in the vacuum-unit cuts leaving high-quality lubricating oils, together with waxes which are separated in methyl ethyl ketone dewaxing units. Finishing operations consist of contact clay treating of lubricating oils and treating and percolation filtering the paraffin waxes.

*Cit-Con Oil Corp., Lake Charles, La.

A very important part of any refining or lubricating-oil operation is the supply and distribution of the various utilities. In limiting this article to a short discussion of the individual utility systems it will be necessary to omit other operational and design features. However, an attempt will be made to emphasize those which seem most important.

Plant Steam Generation

High-pressure steam is produced for the refinery and used as a driving means for refrigerating compressors and cooling water pumps prior to feeding process steam lines for the various units. The steam-generation unit consists of a Graver hot-process water softener, Permutit spray-type deaerator, and three Combustion Engineering Co. integral furnace boilers.

Raw water for the unit comes from deep wells and is pumped to the hot-process softener. This softener is a two-stage process, consisting of a lime-sedimentation tank and phosphate-sedimentation tank. Auxiliary equipment includes a vent condenser, chemical mixing equipment, proportioning equipment, and feed equipment, together with necessary pumps.

The raw water first passes through a vent condenser, condensing steam and allowing the noncondensable gases to escape. These noncondensable gases come over with the steam which has passed through the deaerator, together with gases liberated due to the spray heater in the sedimentation tank. After passing the vent condens-

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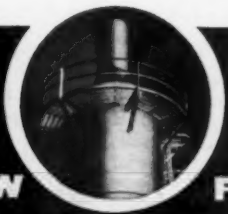

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er, the water goes through the spray heater, which breaks it up into a fine spray for efficient heating by exhaust steam.

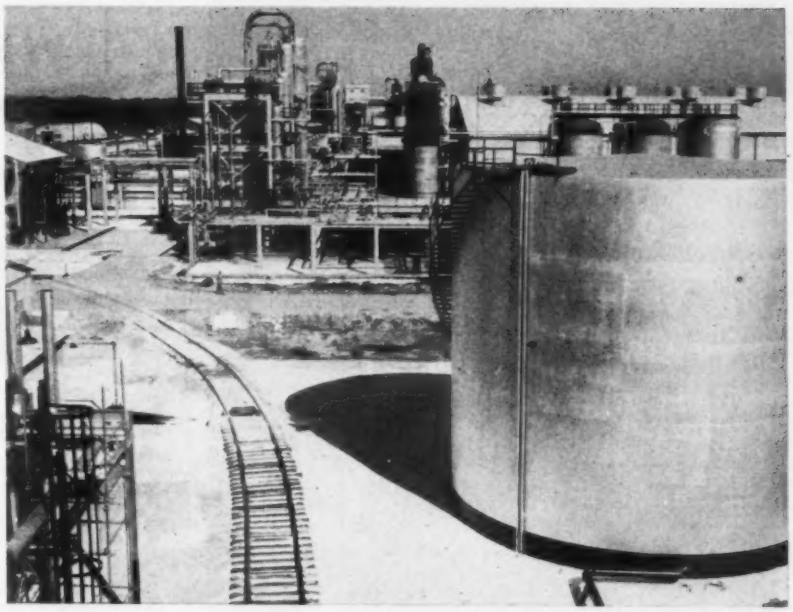
The heated water flows through the downtake of the lime-sedimentation tank, where a slurry made up of dolomite lime (60 per cent CaO + 40 per cent MgO) and activated magnesium oxide is injected and properly mixed by an agitator, then upward through a sludge blanket in the outer rising zone to a takeoff manifold. The water flows by gravity into the downtake of the phosphate-sedimentation tank where a solution of disodium phosphate is injected. Flow of water through the phosphate-sedimentation tank is the same as the flow through the lime-sedimentation tank. A battery of five anthracite-packed pressure filters then removes any turbidity that comes over with the water from the phosphate sedimentation tank.

Briefly discussing the chemistry involved, the raw water, as it comes from the deep wells in this area, has a hardness of 90 p.p.m. (expressed as Ca CO_3) and silica content of 45 p.p.m. To make this water suitable for use in high-pressure, high-temperature boilers it is necessary to reduce the hardness and silica content to a minimum to reduce the tendency for scale laydown within the boilers and on turbine blades.

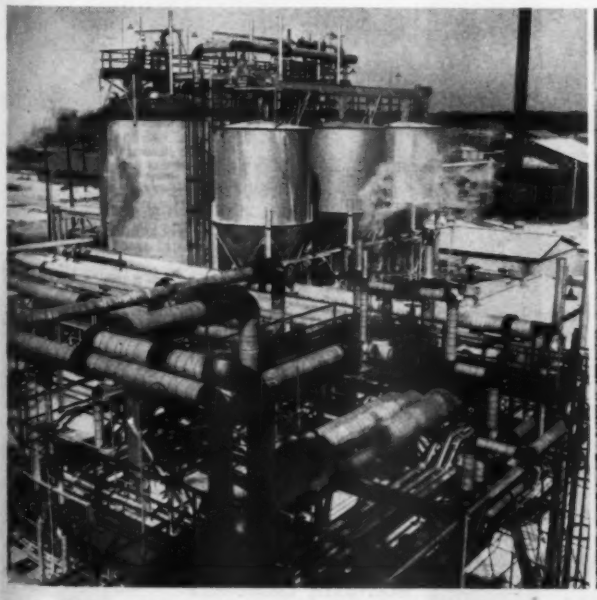
In the lime-sedimentation tank the raw water is mixed with both calcium and magnesium hydroxide. The calcium hydroxide reacts to chemically precipitate the carbonate hardness present in the water by producing insoluble calcium carbonate and magnesium hydroxide. The magnesium hydroxide precipitate is gelatinous in character and serves as a coagulating agent to aid in settling the various other precipitates. In addition to being a coagulating agent, the magnesium hydroxide adsorbs the soluble silica, thereby effectively reducing it to a minimum. Under present chemical treatment the effluent from the lime-sedimentation tank has a hardness of 8 p.p.m. and silica content of less than 2 p.p.m.

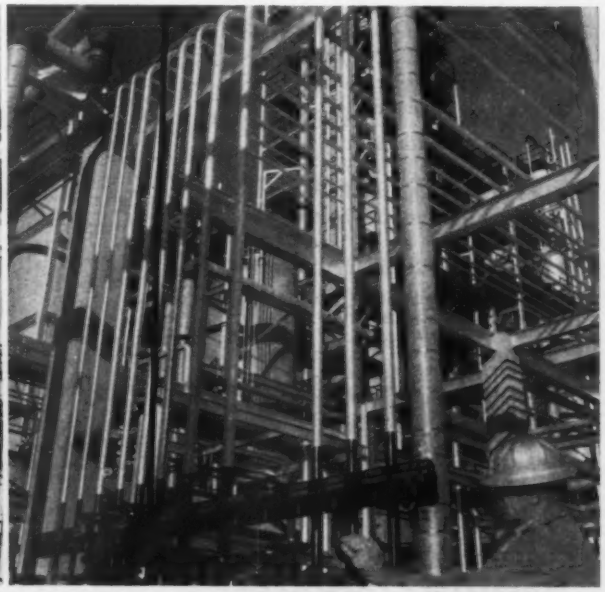
Disodium phosphate is used in the phosphate-sedimentation tank to reduce the remaining hardness to practically zero. A slight excess of soluble phosphate is maintained to drive the reaction to completion and to insure immediate removal of any hardness entering the boiler in the feed water.

Both sedimentation tanks are operated at 240° F. and 15-psi. pressure, and use scrubbing steam from the deaerator as their source of heat. The high temperature gives maximum efficiency of chemical treatment and reduces the sedimentation time required. A high alkalinity (pH 10.0 to 10.3) is maintained in both sedimentation tanks. In the lime-sedimentation tank this high alkalinity decreases the solubility of magnesium hydroxide, thus increasing the efficiency of silica removal. In the phosphate-sedimentation tank a high alkalinity



A view of the No. 2 MEK unit in the world's most modern solvent-refined lube-oil and wax refinery, Cit-Con's plant at Lake Charles, La.





Water treaters and piping at the steam-generating plant in Cit-Con's all-lube refinery. Piping at the furfural unit, right.

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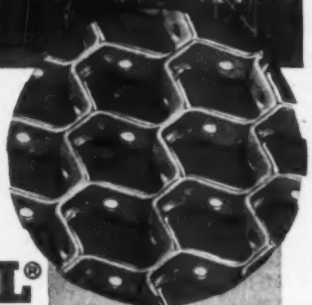

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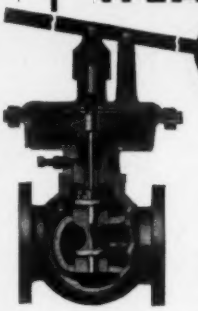

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3. SENSITIVE! Thanks to large diaphragm, weight loading, balanced valve. Built-in by-pass steadies action, prevents pulsation.
4. QUALITY CONSTRUCTION! Offered with all stainless steel trim, renewable seat rings. Close coupled; no packing to maintain. Sizes 2" to 12". ASK FOR BULLETIN G-1.

DAVIS REGULATOR COMPANY

2543 South Washtenaw Ave., Chicago 8, Ill.
***Distributor:* Westcott & Greis, Inc., Tulsa and Houston**

RAMSCO

FREE TURNING

BALL BEARING SWIVEL FITTINGS

FOR LIQUIDS, GASES, STEAM, AND OTHER CHEMICALS. HOT OR COLD SERVICE. CONTINUOUS OR OCCASIONAL ROTATION SERVICE.

360° FREE ROTATION—1, 2 AND 3 PLANES

Your particular piping problems solved. You name it—we have it. Over 500 sizes, types, styles. Sizes: ⅜" to 14" low pressure; ¾" to 6" high pressure. Corrosive service or steam fittings 1000 psi. and temp. to 750°F., asbestos or Teflon packed. Low pressure fitting to 1000 psi. and temp. to 225° F. High pressure fittings to 15,000 psi. and temp. to 225° F. Gear driven types available.

Send for complete catalog and prices. State kind of service, pressure, temperature, pipe size and indicate style at left, threaded, flanged or weld ends.

RASMUSSEN MFG. CO.
12305 INDUSTRIAL AVENUE
HOLLYDALE, CALIFORNIA

RAMSCO

is necessary for complete precipitation of calcium hardness. Sludge recirculation is used in the lime-sedimentation tank to effect chemical savings.

After the water has been treated and filtered it is pumped to a spray deaerator. Here, it is mixed with return condensate and steam scrubbed to release oxygen and carbon dioxide and heated to 250° F. The water then falls into a storage tank from which boiler feed pumps take suction. At this point sodium sulfite is injected to remove any remaining dissolved oxygen. A residual of 15 p.p.m. sodium sulfite is maintained in the boilers. The fully treated water is pumped to a high-pressure feedwater heater which heats the water to 300° F. before entering the boilers.

There are three boilers, each designed to produce 125,000 lb. per hour of steam at 650 psi. and 650° F. They are of the two-drum bent-tube type, designed for outdoor installation of the boiler, duct work, air heater, induced-draft fans and drives, and forced-draft fans and drives. All are presently fired with natural gas, but are equipped with combination gas and steam atomizing oil burners. Efficiency of each boiler is improved by a Ljungstrom air heater which preheats the air to each furnace to 450° F. and cools the hot flue gases to 300° F.

Water is admitted to the individual boilers by means of a perforated header which evenly distributes the water over the entire length of the drum. From the steam drum the water flows through downcomer tubes to the mud drum. On leaving the mud drum the water flows up through tubes within the furnace where the greatest percentage of the steam is generated. By convection, water is also circulated from the mud drum through wall tubes, floor tubes, and roof tubes to the steam drum, thereby cooling the furnace walls.

On returning to the steam drum, the steam first passes through a reversing hood which permits most of the entrained liquid to drop out into the drum. A drying screen then removes the remaining mist before entry into the superheater tubes. From the superheater tubes the steam flows through a superheater header into the 600-psi.-pressure steam system.

Normally all chemical treatment of the feed water is done externally. However, there have been occasions when it has been necessary to inject phosphate directly into the boilers. This has been done through a chemical feed line which is perforated to give good distribution over the entire length of the steam drum.

The concentrations of chemicals in both boiler drum and mud drum are controlled by blowdown. Conductivity meters are used to determine the total solids content of the water in the steam drum and steam to the superheater. These, plus chemical tests, determine whether blowdown rates are sufficient and whether proper chemical concentrations are being maintained within the boiler.

The boilers normally operate at 80 per cent of their design steam rate. To insure that each boiler is ready for sudden large steam demands, a weekly load test of 150,000 lb. per hour is given to each.

Recently all three boilers were opened for inspection and minor repairs. Each had been in service continuously for slightly more than a year and all were found to be clean and in good condition. Nothing in the appearance of the equipment indicated that a change should be made in either the operating conditions or in the method of water treating.

At the present time, some trouble is being experienced with condensate corrosion. It is felt that the chief source of this corrosion is carbon dioxide probably formed from small amounts of carbon and bicarbonate in the feed water. These carbonates undergo thermal decomposition at boiler temperature and liberate carbon dioxide which becomes entrained with the steam. In an attempt to combat this type of corrosion an organic amine compound is being injected directly into the main steam

New "Line" Tool

UNI-CHANNEL
SENSICON DISPATCHER
the *best* in low-cost
2-WAY RADIO

Take it along—Anywhere, it's built to take it. Eliminates outage, mileage, maintenance costs.

Long, trouble-free operation and protection against obsolescence.

No less than EIGHT exclusive MOTOROLA developments make it your first choice in low-cost 2-way mobile radio!

FM 2-WAY RADIO
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SPECIALISTS IN MOBILE RADIO FOR 20 YEARS

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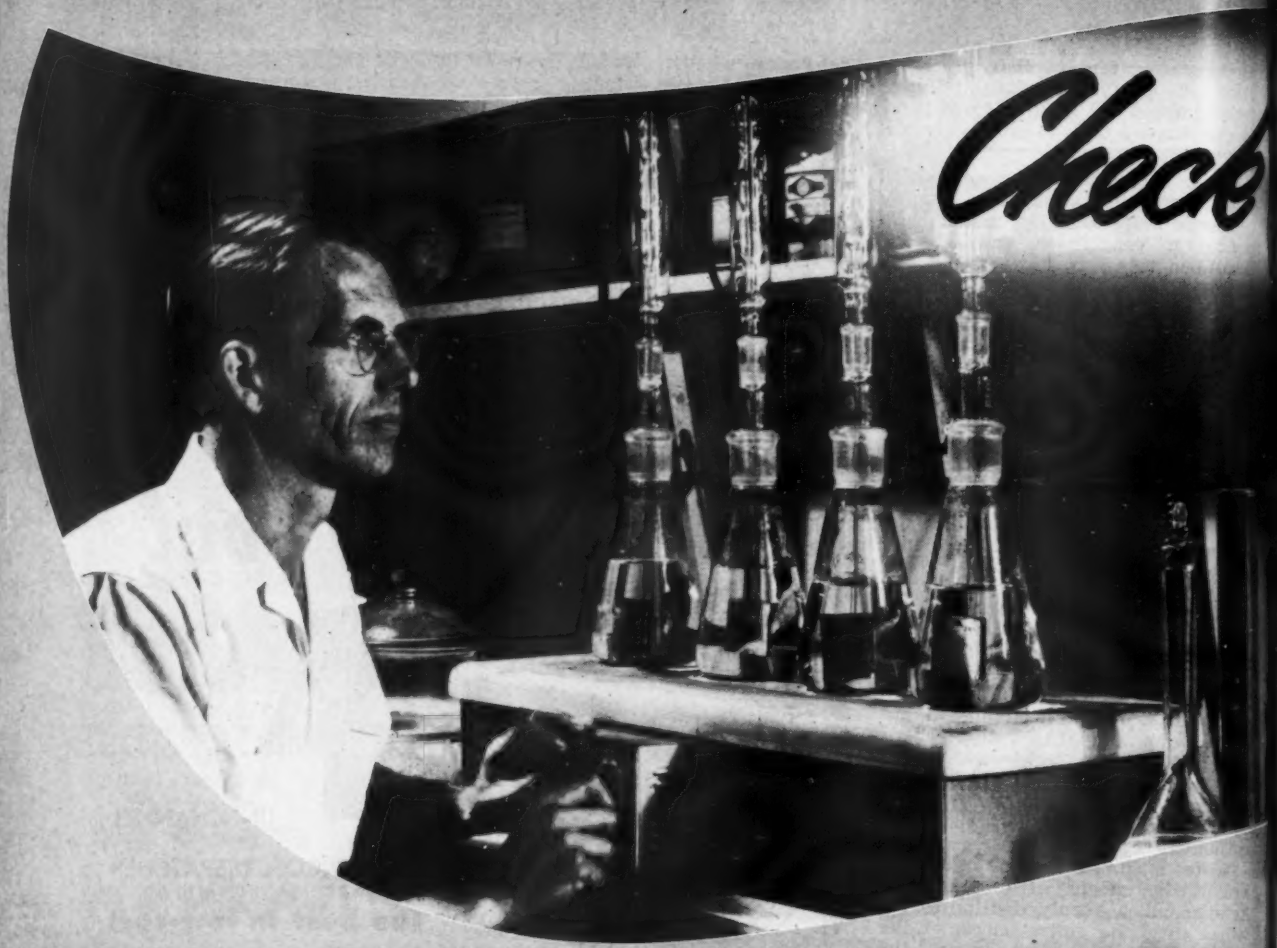


Typical Applications in which Ampco Alloys have been used with Cost-Saving Success

Absorption columns	Condenser tubes	Fittings — forged, cast	Perforated plate	Studs
Acetylators	Condenser tube sheets	Forgings	Pickling baskets	Sucker rod
Acid chain	Control valves	Fractionating columns	Pipe and fittings	Tanks
Agitators	Conveyors	Hangers	Plug cocks	Tools, safety
Autoclaves	Coolers	Heat exchangers	Pressure vessels	Towers
Baskets	Crystallizers	Heater coils	Pumps	Trays, fractionating
Bearings	Dephlegmators	Hooks	Reboilers	Tubes and tubing
Beater bars	Digesters	Injectors	Retorts	Vats
Bellows	Ejectors	Instrument cases and elements	Rivets	Valves
Bolts and nuts	Evaporators	Kettles	Safety tools	Welding rod
Brazing rod	Evaporator tubes	Line hardware	Screens	Well tubing
Brine coils	Extractors	Meter cases	Screws, conveyor	Wire
Bubble caps and trays	Fabricated assemblies	Mixers	Sludge burners	Woven wire cloth
Calandrias	Filters and filter screens	Pans, evaporator	Springs	
Condenser shells	Filter presses		Stills	

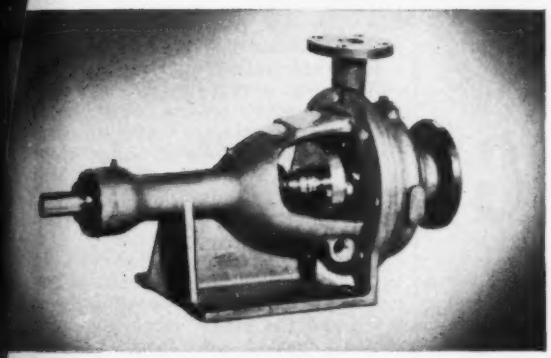
Chemical Agents and the Applicability of AMPCO Alloys

Acetate Solvents (Pure)	E	Carbon Dioxide		Hydrogen Sulfide		Potash Crudes	E	Toluene or Toluol	E
Crude	G	Dry	E	Wet	NR	Propane	E	Tri Chlorethylene	E
Acetic Acid		Wet	G	Dry	F	Shellac	E	Tri Sodium Phosphate	E
Crude	E	Carbon Disulfide	F	Lacquers and Lacquer Solvents	E	Soaps	E	Turpentine	E
Vapors	E	Carbon Tetrachloride	E	Lactic Acid	E	Soda Ash		Varnish	E
Acetic Anhydride	G	Caustic Soda	E	Magnesium Chloride	G	(Sodium Carbonate)	G	Vegetable Oils	E
Acetone	E	Chlorine		Magnesium Hydroxide	E	Sodium Bicarbonate	E	Water	
Acetylene	NR	Dry	G	Magnesium Sulfate	E	Sodium Bisulfate	E	Fresh	E
Alcohols	E	Wet	NR	Malt Beverages	E	Sodium Carbonate	E	Salt (includes	
Aluminum Fluoride	G	Chloroform	E	Mercuric Chloride	NR	Sodium Chloride	E	Polluted Harbor)	E
Aluminum Sulfate	G	Chromic Acid	NR	Mine Water (Sulfate)	E	Sodium Cyanide	NR	Xylene	E
Aluminum Hydroxide	E	Citric Acid	E	Molasses	E	Sodium Hydroxide	E	Zinc Chloride	G
Ammonia Gas		Copper Sulfate	NR	Monochlorobenzene	E	Sodium Nitrate	G	Zinc Sulfate	E
Dry	G	Crude Oils — Sour	G	Muriatic — Cold, Commercial	G	Sodium Perborate	E		
Wet	NR	Esters	E	Naptha	E	Sodium Peroxide	F	These ratings may usually be interpreted as follows:	
Ammonium Chloride	NR	Ethers	E	Natural Gas	E	Sodium Phosphate			
Ammonium Hydroxide	NR	Ethylene Glycol	E	Nickel Chloride	F	Alkaline	E	E — Excellent IPY Penetration $<0.006''$	
Ammonium Nitrate	F	Ethyl Sulfate	E	Nickel Sulfate	G	Neutral	E		
Ammonium Phosphate	F	Ferric Chloride	NR	Nitric Acid	NR	Acid	G		
Ammonium Sulfate	F	Ferric Sulfate	NR	Nitrogen (Dry)	E	Sodium Silicate	E	G — Good IPY Penetration $<0.016''$	
Amyl Chloride	E	Formaldehyde	E	Oleic Acid	E	Sodium Sulfate (Soda Cake)	E		
Asphalt	E	Formic Acid	E	Oxygen	E	Sodium Sulfide	NR		
Barium Chloride	G	Freon	E	Paint Vehicles (Except Soya-Oil)	G	Sulfur	F	F — Fair IPY Penetration $<0.050''$	
Beer	E	Furfural	E	Palmitic Acid	E	Sulfur Chloride	NR		
Beet Sugar Liquors	E	Gasoline	E	Petroleum Oils		Sulfur Dioxide			
Benzene or Benzol	E	Gelatine	E	Sour	G	Dry	G	NR — Not Recommended IPY Penetration Over $0.050''$	
Borax	E	Glucose	E	Refined	G	Wet	G		
Boric Acid	E	Glycerine	E	Phenol	E	Sulfuric Acid			
Brine	E	Hydrocarbon Gases	E	Phosphoric Acid	E	5%)	E	In using this data, it should be understood that these are results of specific tests and are indicative of those conditions under which the tests were run, and are a basis for recommendation, but not	
Butane, Butylene	E	Hydrochloric Acid		Pickling Acid		10%)	E		
Butadiene	E	to 5%	G	(except Nitric Chromic)	E	25%) Up to Boiling	E		
Butyric Acid	E	to 10%	F	Potassium Chloride	E	35%)	E		
Calcium Bisulfite	G	(see Muriatic)		Potassium Cyanide	NR	50%)	E		
Calcium Hydroxide	G	Hydrocyanic Acid	NR	Potassium Hydroxide	F	Sulfuric Acid Sludge	E		
Calcium Hypochlorite	F	Hydrofluoric Acid	G			Sulfurous Acid	G		
Cane Sugar Liquors	E	Hydrogen Fluoride (Dry)	E			Tannic Acid	G		
		Hydrogen	E						

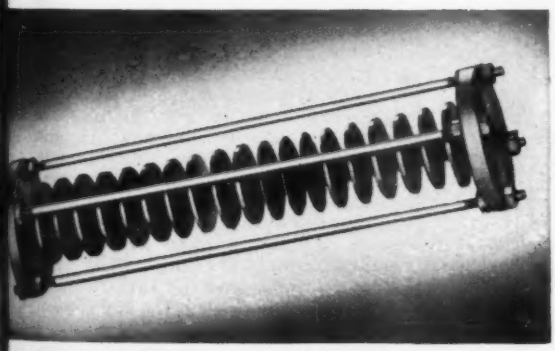
AMPCO®

Your Corrosion Problems ...use Ampco Alloys

...these unique properties have proved to be the best answer to many process equipment problems



Ampco Centrifugal Pumps — Here — for the first time in pump manufacturing history — is a "production-built" and "production-priced" pump to handle acids, alkalies, and other corrosive agents hitherto requiring specially built pumps. The Ampco single-stage, single-suction centrifugal pump offers long life, high efficiency and low maintenance costs through the combination of correct design and properly selected materials.



CORROSION TESTING—Types of Test Specimens — A complete stock of test specimens of a wide variety of materials is kept ready for mounting on racks. Several forms of racks are available for tests in atmospheric locations, pipe lines, tanks or other pressure vessels. When requesting test specimens please outline conditions under which test is to be conducted so that we may supply the most suitable form.

1. High resistance to corrosion
2. High tensile strength
3. High physicals at extreme temperatures
4. High strength to weight ratio
5. High impact and fatigue values
6. High wear-resistance — to erosion — corrosion — cavitation, etc.
7. High compressive strength
8. High modulus of elasticity

Designers and plant engineers in the process industries are turning to Ampco Alloys more and more frequently — because of the outstanding savings offered by their long-lasting qualities.

Costs are reduced in three ways: 1. Minimum down time, 2. Minimum product loss from parts failure, and 3. Minimum maintenance and replacement expense.

Study the list of time-proven applications and the Ampco applicability chart and apply this data to your own needs. Plan your own economies now by specifying Ampco Bronze Alloys for corrosive and erosive media handling. Write today for recommendations and complete information.

★ ★ ★

Ampco aluminum bronzes are available in a number of grades to meet your exact requirements in any form you need: rolled sheet or plate, sand or centrifugal castings, forgings or extrusions . . . pipe and fittings. Also, Ampco's arc-welding electrodes, corrosion-resistant centrifugal pumps and plug valves.

Free . . .
Process Industries Bulletin — 16 pages of money-saving information.

AMPCO®

Ampco Metal, Inc.
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West Coast Plant *Burbank, California*

Ampco Metal, Inc., Dept. OG-3, Milwaukee 46, Wis.

Send me your free bulletin, giving full information on the application of Ampco Alloys in the Process Industries.

Name..... Title.....

Company.....

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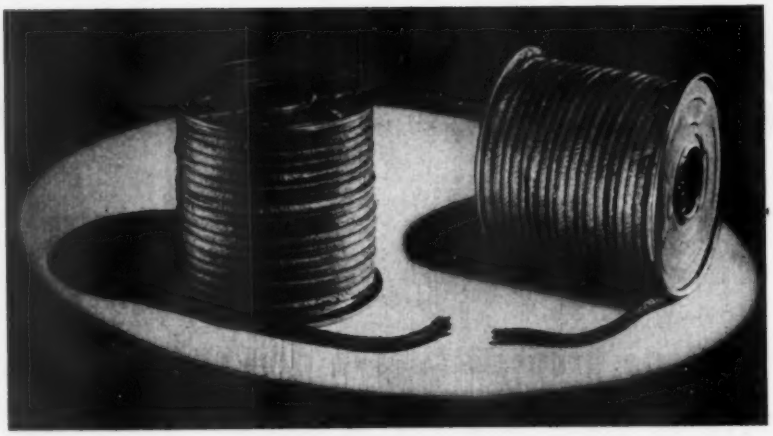

EXTRUDED TEFLON PACKING

A Chemical-Proof Field Maintenance or Emergency Packing

For valves, pumps, agitators, autoclaves, couplings or any other stuffing box application, Chemiseal #620EG (impregnated with graphite) or #620EM (with mica) extruded Teflon packing is ideal for field maintenance or emergency use where it is impractical to have preformed packing rings made to order. Like all Teflon-"Chemiseal" products, #620EG or EM can't be attacked by *any* organic or inorganic acid, alkali or solvent. #620 is serviceable from −150° F. to 550° F.

"Chemiseal" extruded Teflon packing differs from other shredded oriented Teflon packings in that no synthetic or rubber binders are used in its fabrication—such additives tend to harden and render the packing unserviceable. Lubrication of the packing is enhanced by use of a highly acid-refined, non-nitridable hydrocarbon which, while soluble in common solvents, is unaffected by aqueous solutions of inorganic acids or alkalis. However, Chemiseal #620 is definitely recommended for solvent applications as the lubricant is not essential for anti-friction purposes.

#620 Packing is supplied in coil form, in a loosely-woven cotton jacket. It is sold by the foot and is available in rectangular cross-section from ¼" up by 1/16" increments. Send for Catalog Nos. 620EG and 620EM.

UNITED STATES GASKET CO.

677 N. 10th Street • CAMDEN, NEW JERSEY

line from the boilers. This compound forms a monomolecular film on the metal wall and prevents either carbon dioxide or oxygen from attacking the metal. As this treat has just begun it is not yet possible to determine how effective it will be until test specimens and some of the equipment in contact with condensate have been examined.

Cooling Water

Cooling water for the process units is provided by a 51,000-g.p.m. induced-draft cooling tower designed and built by Water Cooling Equipment Co. The tower is designed to cool the return water from 117° to 92° F. at a maximum wet-bulb-temperature approach of 5° F. There are 17 two-cell sections with each cell containing a 14-ft.-diameter fan capable of pulling 153 cu. ft. per minute of air per gallon of water distributed to the cell.

Hot water returning from the processing units enters the cooling tower through a 48-in. redwood-stave header which distributes water to each pair of cells. The cooled water drops into a basin under the tower which holds approximately 575,000 gal., giving a holding time of 11 minutes when circulating at capacity.

The circulating water pumps are supplied by a 72-in. underground line running between the cooling-tower basin and the pump house, in which they are located, a distance of approximately 1,000 ft. There are six pumps each rated at 8,500 g.p.m. Three are driven by turbines utilizing 600-psi. steam exhausting to the 200-psi. steam system, and three are driven by 500-hp. synchronous electric motors. All pumps discharge into a common header which in turn supplies each processing unit.

In passing through the cooling tower part of the water is lost by evaporation. By virtue of this loss, dissolved solids that come in with the makeup water become concentrated in the cooling-water system. To remain within the solubility limits of the particular solids that are present, it is necessary to continuously blowdown enough water to keep within specified concentrations. With the chemical treat used at this refinery six cycles of concentration have been satisfactory.

Sulfuric acid is continuously injected into the cooling water to prevent the alkalinity, as determined by methyl orange indicator, from going above 75 p.p.m. The acid converts calcium bicarbonate into the more stable and soluble calcium sulfate, thus preventing the carbonate from precipitating and being deposited within the heat transfer equipment.

A surface-active material having a phosphate-chromate base is also injected into the cooling water. This material increases the solubility of scale-forming salts and permits an oversaturated condition of the salt to be present without appreciable precipitation. The surface-active metal also

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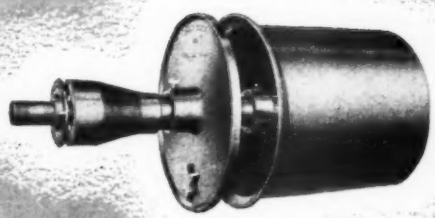
BI-MIX BURNERS for REFINERIES



SERIES HBM —

SHORT FLAME GAS BURNER.

Inexpensive to buy—easy to install. All in one piece—just brick into furnace wall.

Can be used with high or low pressure gas.

Slugs of water, oil or gasoline blow through them or run down over them without doing damage.

Available for vertical or horizontal firing.

Burns with a short flame, without the use of small ports. refinery gases, natural gas, oil vapors or a mixture of gases.

SERIES CBM —

COMBINATION GAS & OIL BURNER.

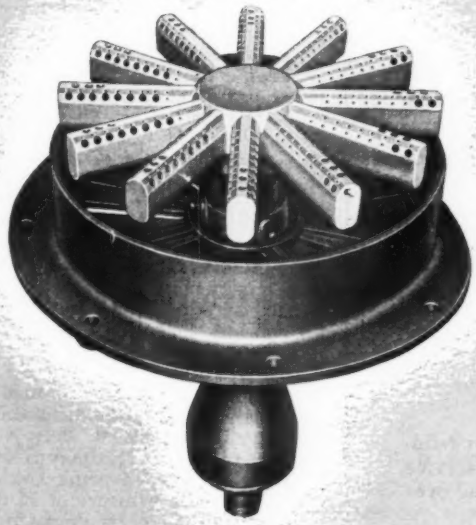
Full rating may be taken with completely satisfactory fires with either fuel.

Both fuels may be fired in combination if necessary.

A new file and register design permits operation at low excess air.

Any gaseous fuel at pressure in excess of 5 lbs. may be burned.

Any commercial grade of fuel oil may be burned when properly prepared.



SERIES VBM —

GAS & COMBINATION GAS & OIL BURNER.

They permit the release of more units per cubic foot of furnace volume.

They are the first really satisfactory combination gas and oil burners for vertical firing.

They permit perfectly even distribution of heat in the furnace.

Any gaseous fuel at pressures in excess of five pounds may be burned perfectly satisfactory.

Any commercial fuel oil may be burned when properly prepared.

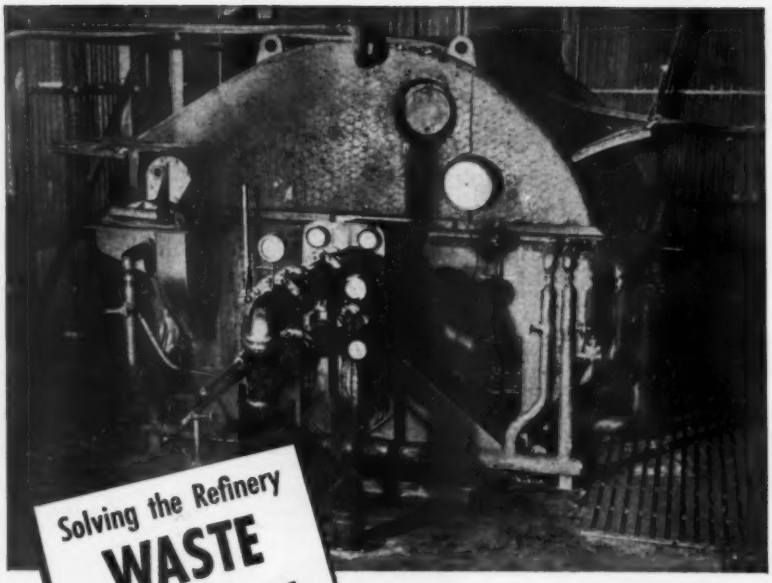
Extreme simplicity of design and ease of control prevent operational difficulty.

High sulphur content gases may be burned without port sloppage.

They give maximum duty with a minimum of furnace draft.

JOHN ZINK COMPANY

4401 South Peoria — Tulsa, Oklahoma



Solving the Refinery
WASTE DISPOSAL PROBLEM
. . . automatically, economically!

OLIVER PRECOAT FILTER

Trap residues—separator box emulsions—sludges . . . the Oliver Precoat Filter can effectively handle these wastes by dewatering sludges and breaking oil-water emulsions, resulting in stocks for refinery re-run and water ready for disposal in public streams. For example, a refinery is obtaining an oil phase carrying only 2/10 of 1% sludge and only a trace of water; the water phase is comparatively oil-free.

Oliver United engineers, calling on their 42 years of filtration experience and their many varieties of filter types, developed this closed type, continuous vacuum precoat filter for handling refinery wastes. It's proving a boon to refineries in connection with this vexing problem.

A letter or phone call to our nearest office will have a skilled refinery filtration engineer at your plant whenever desired to make a study and recommendations for a filtration plant to handle the wastes properly.

• • •

Another very profitable use of the Oliver Precoat Filter in refineries is in connection with contact clay handling. Many are in service providing continuous handling, great reduction in oil losses over other methods, and more easily handled cake.

OLIVER UNITED FILTERS INC.

New York—33 West 42nd Street
Chicago—221 N. La Salle Street
Oakland—2900 Glascock Street
San Francisco—260 Calif. Street
Factories: Hazleton, Pa. • Oakland, Calif.
Export Sales Office—New York

Cable—OLIUNIFILT

acts as a corrosion inhibitor. It forms a protective film on the metal surface thereby rendering the metal passive to oxygen attack. Since the film is microscopic in thickness it does not appreciably interfere with heat transfer.

The success of the above chemical treat is borne out by experience which has shown that it is possible to operate the heat-transfer equipment for a least 1 year without appreciable corrosion or loss in heat-transfer capacity.

In open circulating cooling-water systems there is the ever present trouble with slime and algae in the cooling tower, lines, and equipment. Here at this refinery, shock treatment with chlorine has been used successfully. A Wallace & Tiernan chlorine-injection unit is connected to a 2,000-lb. cylinder of chlorine. Once per week the injector is placed in service, injecting sufficient chlorine to build the concentration up to 2 p.p.m. This residual is held for a period of 12 hours before taking the injector out of service.

Electric Power

Electric power is supplied to the refinery by means of two 13.8-kv. cables from the nearby Cities Service Refining Corp. power-plant switchboard. The two cables feed two substations which are located within the refinery. The power load has been split so that a portion of the equipment is supplied through transformers at the substations from both feeder lines. Switches are provided at the substation that will permit serving the transformers from either feeder cable (at a reduced load) in case of failure of one feeder cable.

All motors of 125 hp. and over are supplied with 2,300-volt power and less than 125 hp. with 440-volt power.

Two emergency turbogenerator units can supply limited power to operate electrically controlled instruments and limited lighting in case complete power failure occurs. Switch to emergency supply is automatic, but change to normal again is manual.

Well Water

Three deep wells supply fresh water to the refinery through interconnected underground lines. Two of the wells are 500 ft. deep and the other is 700 ft. The pumps on each are capable of delivering 1,500 g.p.m. at a discharge pressure of 75 psig.

The well water is normally 72° F. which is cooler than the circulating water during summer months. Therefore, at this time, the 700-ft. well is primarily used to supply water to the vacuum unit precondensers and intercondensers which require cooling water between 70° and 80° F. A portion of the return water from the vacuum units is used as makeup for the circulating-water system. During winter months the circulating water is sufficiently cool to permit its use in the vacuum unit condensers

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a FLORIDIN DESICCANT

The high-pressure dehydration unit here illustrated is a property of the United Gas Pipe Line Company at Carthage, Texas. It represents the most advanced design, construction, and operating technique; and the drying agent employed is FLORITE DESICCANT. The Stone & Webster Engineering Corporation, who designed and constructed the plant, are users of FLORITE in various types of equipment, large and small, for oil and gas companies and for other branches of industry.

Natural gas, propane, butane, gasoline, air, nitrogen, carbon dioxide, refrigeration compounds, all are treated with superior drying efficiency by use of FLORITE. Selectively adsorbs 4 to 20% its weight of water—is regenerated by heating to 350°F. Write for literature, names of important users in your own field.

FLORIDIN COMPANY

Adsorbents . . . Desiccants . . . Diluents

Department C, 220 Liberty St., Warren, Pa.

Cooling Tower Service

A "Natural" For The

JOHNSON Right Angle GEAR DRIVE

ECONOMICAL...Use of available steam at 3600 RPM turbine with pump speeds as low as 1200 RPM.

COMPACT.....An extremely compact installation, with simplified piping, is possible through the use of a Johnson Drive and vertical turbine pump.

VERSATILE.....Horizontal electric motors can also be used in conjunction with the Johnson Drive. In the event of motor breakdown, a horizontal motor is usually obtainable for replacement more readily than a vertical motor.

CONTINUOUS OPERATION.....Where uninterrupted service is necessary, Johnson supplies a Right Angle Drive for combination electric motor and steam turbine service.

AVAILABLE.....In a number of sizes and types to meet varied applications.

INVESTIGATE....The Johnson Drive sold through pump manufacturers. Catalog with full engineering data sent on request.

The Johnson Right Angle Gear Drive is in use throughout the world, serving industry at low-operating cost and high efficiency.

JOHNSON GEAR

AND MANUFACTURING CO.

MAIN OFFICE & WORKS • BERKELEY 10 • CALIFORNIA

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You can't jam the new RIDGID 65R

Really streamlined pipe threading with this RIDGID self-contained die stock

Right Here is the simple device that makes 65R automatically *JAM-PROOF*.

● You don't have to watch it—lead screw can't jam on workholder. New jam-proof drive plate automatically kicks out driving ratchet pawl when standard length thread is cut. Your recent model 65R easily converted—just buy new drive plate, put in place of old plate. Perfect threads on 1″ to 2″ pipe with one set of 4 high-speed steel dies—sets to pipe size in 10 seconds, mistake-proof self-centering workholder sets instantly! Buy the new jam-proof RIDGID 65R at your Supply House.

RIDGID

★ Work-Saver Pipe Tools ★

and therefore the 700-ft. well is shut down.

Water from one of the 500-ft. wells provides cooling for the wax slabbing unit presses before supplying the well water header. The other 500-ft. well also provides water for the well water header which in turn supplies the boiler feed-water treating, drinking water, office air conditioning, and circulating-water systems.

The lines in the fire-water system are normally under 75 psi. pressure, supplied by the circulating cooling-water pumps. In case of fire a check valve permits isolating the circulating-water and fire-water systems. Fire water at 178 psi. can then be delivered by two steam-driven pumps. These pumps are rated at 750 g.p.m. each and take suction from the forebay of the circulating cooling-water system. It is necessary to increase the makeup water to the circulating cooling-water system when these pumps are in use.

The drinking-water system is supplied by the well water header. A chemical treating system injects sufficient chlorine in the form of sodium hypochlorite to destroy bacteria. A test for free chlorine is run on the water every 8 hours and the residual is maintained at 0.2 p.p.m.

Plant and Instrument Air

The plant and instrument air systems are supplied compressed air by three Ingersoll-Rand duplex reciprocating units. One compressor is steam driven and the other two are driven by synchronous electric motors. They are rated at 1,320 and 1,324 cu. ft. per minute at 110 psi. discharge pressure. Normally one motor-driven and one steam-driven compressor are in service. All compressors discharge into a common header which is piped to an air receiver. The air receiver supplies air to the plant air headers and to the instrument air system.

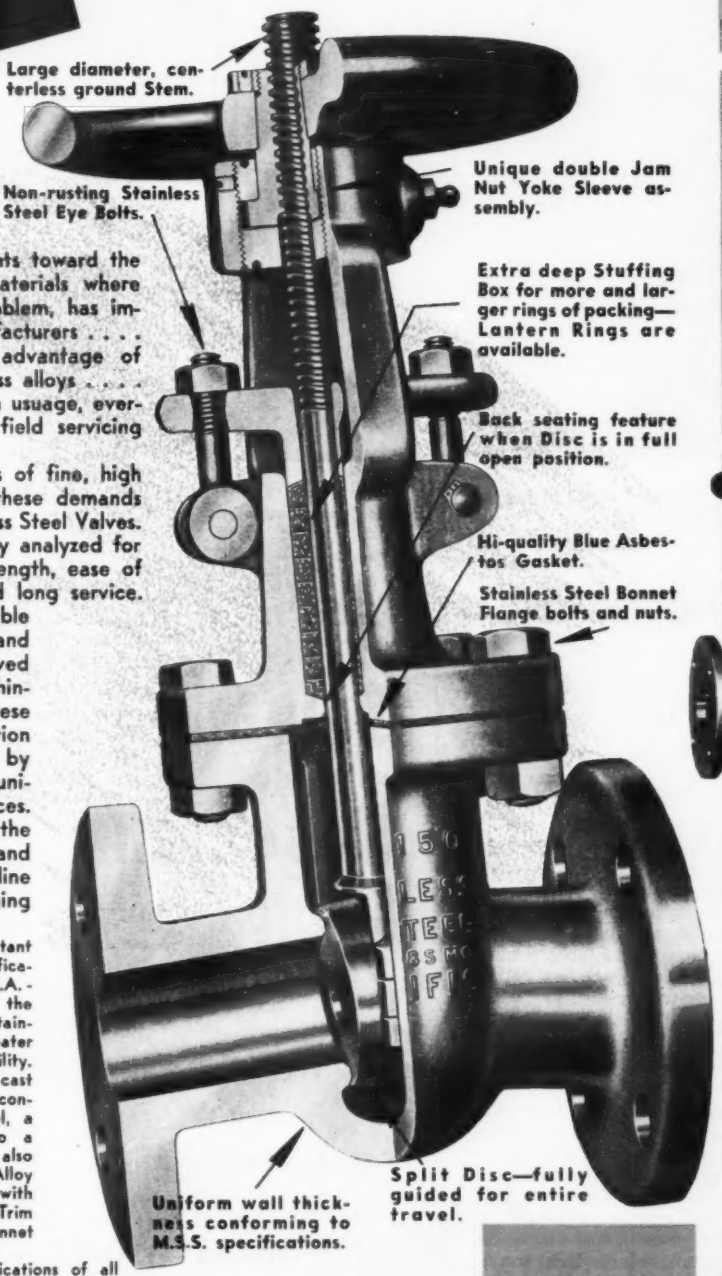
The instrument air system has a Pittsburgh Lectrodryer and filter which removes moisture and any foreign matter prior to use in instruments. Interconnecting control valves on the instrument air header and the plant air header regulate the pressure on the instrument air system at 100 psi. and if, for some reason or other, the plant air-supply pressure is rapidly lowered, then the valve on the plant air header will close sufficiently to maintain pressure on the instrument air-system, assuming that the compressors are operating normally.

Fuel Gas

A 10-in. line supplies natural gas to the refinery at 75 psi. pressure. Within the refinery the pressure is reduced and controlled by dual control valves at 45 psi. before entering a dry-gas drum. The gas then enters a fuel-gas header which in turn supplies each of the various operating units.

A RELIABLE LINE....

PACIFIC'S CORROSION RESISTANT VALVES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Back seating feature when Disc is in full open position.
Hi-quality Blue Asbestos Gasket.
Stainless Steel Bonnet Flange bolts and nuts.
Split Disc—fully guided for entire travel.
Uniform wall thickness conforming to M.S.S. specifications.

Fig. No. 500 1½" - 150 Lb., Gate Valve O. S. & Y.

The trend in modern process plants toward the wider use of corrosion resistant materials where corrosion or contamination is a problem, has imposed new demands on Valve manufacturers . . . . demands for Valves to take full advantage of the remarkable properties of stainless alloys . . . . demands for sturdy Valves for rough usuage, ever-ready tight closures, simple, quick field servicing and low reconditioning costs.

Pacific Valves, Inc., manufacturers of fine, high quality, cast steel Valves has met these demands with their popular line of cast Stainless Steel Valves. The design of each Valve is carefully analyzed for the optimum in "flow of fluid", strength, ease of operation, ease of maintenance and long service.

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Pacific's 150 Lb. Series, corrosion resistant Valves are manufactured to M.S.S. specifications. The 600 Lb. Series conforms to A.S.A.-A.P.I. specifications. Rigid control of the Chemical and Physical properties of these stainless alloys have resulted in alloys of greater corrosion resistance, strength and machinability.

Pacific regularly furnished these Valves cast of Pacific's Alloy 316 Stainless Steel which conforms to A.I.S.I. Type 316 Stainless Steel, a non-magnetic, austenitic alloy, passive to a wide range of corrosives. These Valves can also be supplied from stocks cast of Pacific's Alloy 20, a widely popular Stainless Steel with improved resistance to sulfuric acid. Trim materials are equal to the Body-Bonnet materials specified.

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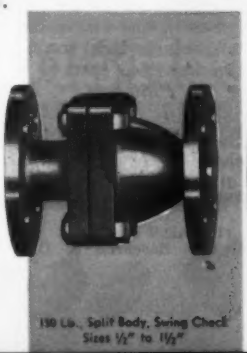
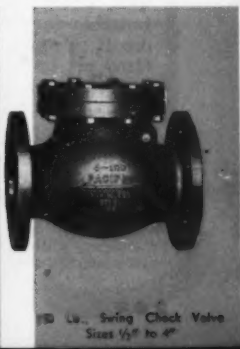
150 Lb., Inside Screw Gate Valve, Sizes ½" to 2"

150 Lb., O. S. & Y., Globe Valve Sizes ½" to 6"

400 Lb., O. S. & Y., Gate Valve Sizes ½" to 8"


150 Lb., Split Body, Swing Check Sizes ½" to 1½"


150 Lb., Swing Check Valve Sizes ½" to 4"

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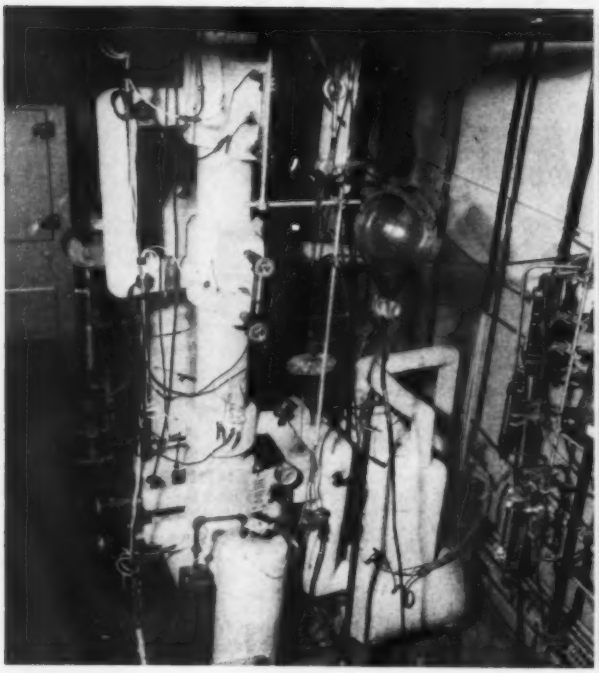

Left: Catalytic treating unit operated by Cities Service Research & Development Co.'s Lake Charles, La., laboratory. Right: Control panel for the Lake Charles catalytic pilot plant.

Here's a method you may find useful in the problem of

Selecting Research Projects

by W. W. Scheumann*

and

H. L. Malakoff†

Here's a rating system the authors have found to possess considerable merit. Some of its shortcomings are pointed out in a frank appraisal.

IT is quite widely accepted that the petroleum industry is one of the most progressive. The expenditure of over $100,000,000 per year for research is certainly one sound testimonial to this fact.

The sums allocated for research are generally limited for most companies for two reasons. First, by the fact that even though only a small percentage of the research projects are usually brought to successful conclusion, most companies have limited capital funds with which to follow up the research with necessary plant additions or new facilities.

Secondly, research, like every other company operation such as marketing, production, and refining, can only be justified by the fact that it will bring a return to the company. As such it must compete with other departments for operating funds. That return may be in the form of good will, advertising value, or other intangible factors, but in the end must result in more business or help maintain present business to insure a dollar return for the company.

Research expenditures are, however, certainly not limited by the want of research ideas or problems. Every research director most certainly has 5 or 10 times as many suggested problems as he has funds to carry them out. This certainly is a healthy situation and research management does not desire to discourage research suggestions of any kind whether they originate from the research personnel or operating-department personnel. The big problem which faces all research groups is how to select those problems which have the best chance of success and will bring the maximum return to the company.

It would be surprising if any two oil companies select their research problems by the same methods. In many companies, top management dictates the fields of company interest, the company's general plans for the future, and then allows the research manager or director and his associates to select problems that will tie in with the general over-all company policy and plans. Other companies allow the research director complete authority in selecting problems of his own choosing. Still other companies have their research program set up by supervisory committees or boards. The "extreme" situation exists in those companies which permit the research personnel to work on problems of their own choosing.

One method of selecting a research program is presented here. The authors in no way represent it to be the "last word." It certainly is open

*Manager and †technical assistant to manager, Cities Service Research & Development Co.

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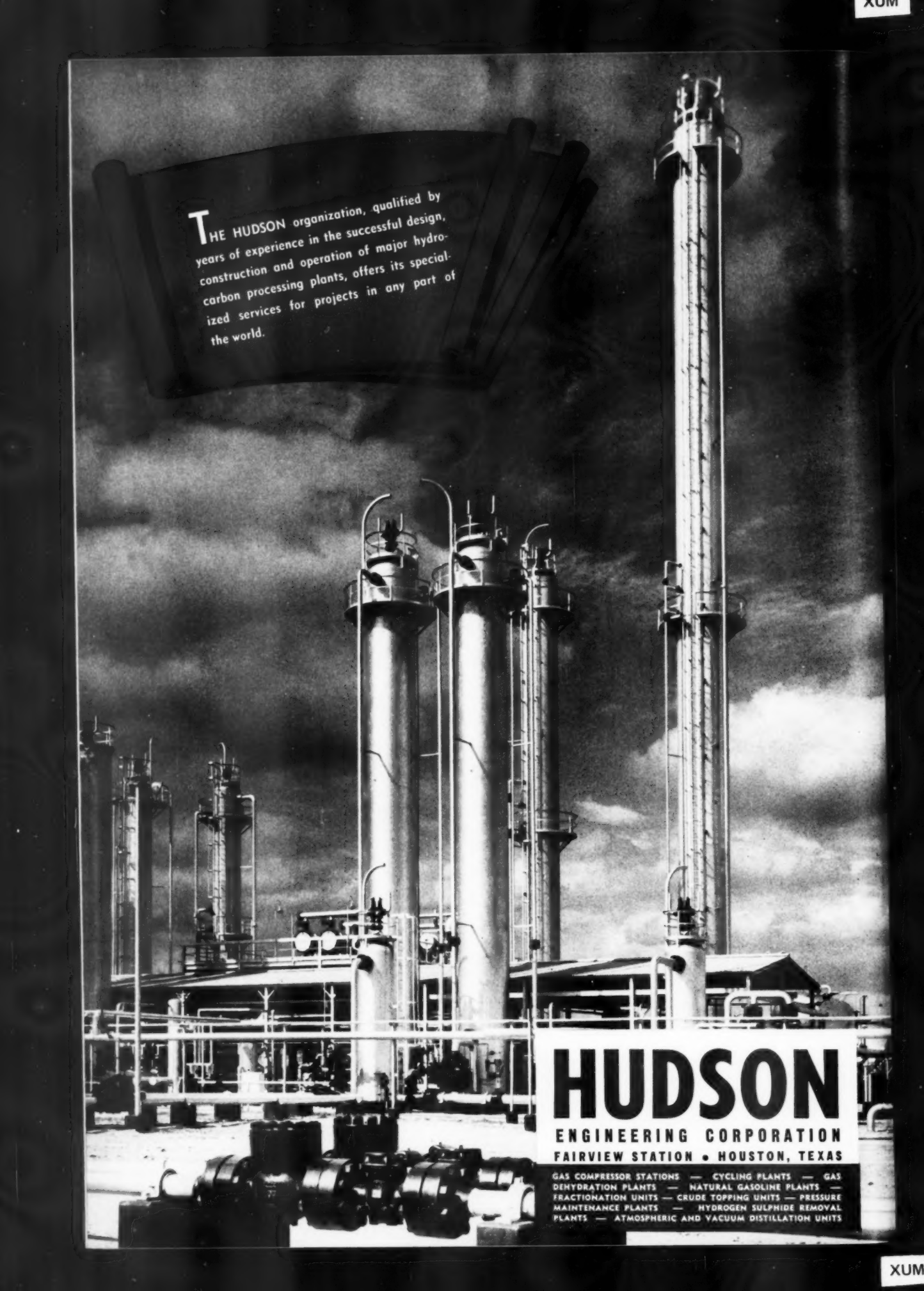
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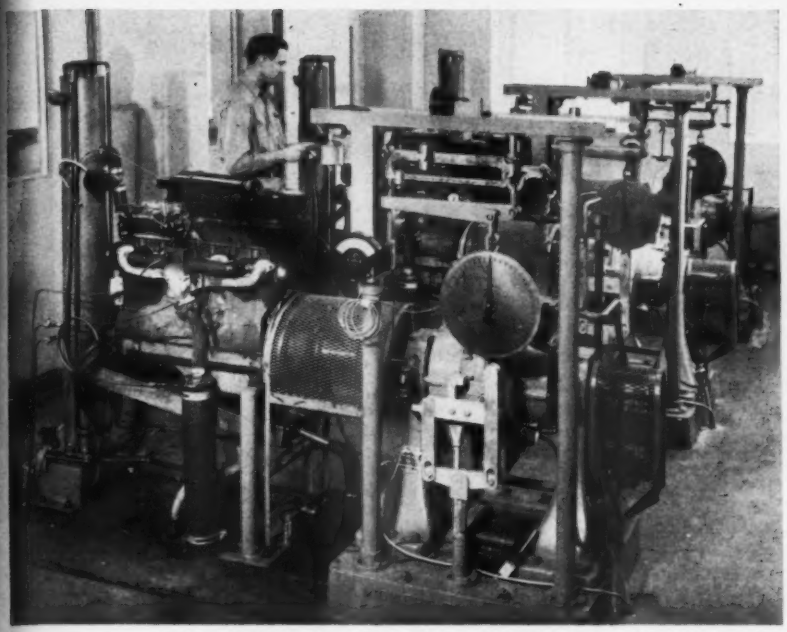

A section of the engine test laboratory at the research and development company's East Chicago laboratory. Two other Cities Service research laboratories are maintained at Hillside and Linden, N. J.

to much criticism from many angles: some of its obvious weaknesses and some of the objections voiced to it are presented later in the article. The method is not applicable to all types of problems, and certainly essential and service research functions must be carried on despite the fact that they are not amenable to this selection and rating system. Experience during the past few years has indicated that possibly 75 per cent of a company's research program might be set up in this manner.

TABLE 1

Title: .....

1. Statement of Problem
   .....
   .....
2. Estimated Research Requirements
   (a) Scope: .....
   (b) Time-Manpower: ..... man hours
   (..... men for ..... years)
   (c) Costs: .....
3. Estimated Economics if Project Is Successful
   (a) Plant Size: .....
   (b) Investment: .....
   (c) Raw Material Cost(s): .....
   (d) Total Manufacturing Cost: .....
   (e) Product Price(s): .....
   (f) Annual Earnings: .....
   (g) Payoff: ..... year(s)
   (h) Assumptions: .....
4. Secondary Benefit to Company
   .....
   .....
5. Remarks
   .....
   .....
6. Chances of Project Success
   .....
   .....

The first step in this project rating scheme is to work up each and every project in the form shown in Table 1. This basic form is, of course, altered slightly depending whether the problem is on petroleum product development, process improvement, petrochemicals, etc. A brief explanation of the sections of this writup form follows:

1. **Statement of the problem.**—Every endeavor is made to make this statement as brief, clear, and nontechnical as possible. In Cities Service Research & Development Co., the research committee, which has the responsibility for approving the research program submitted by the manager of research, is made up of representatives from the company marketing, refining, production, transportation, and research departments.

2. **Estimated research requirements.** The section is essentially set up based on experience factors of the supervisory research personnel with similar problems in the past. Under "scope" is those phases such as laboratory, bench scale, pilot plant, semicommercial, field testing, market survey, etc., which are necessary to bring the problem to a successful conclusion. The "time-manpower" involved is, of course, estimated from the scope of the problem and experience factors on similar type problems completed in the past. Past accounting records permit estimating the cost that will be involved.

3. **Estimated economics if project is successful.**—This is the heart of the writeup. It is an educated estimate of the return to the company if the project is carried to a successful conclusion. Items a, b, c, d, and e, are self-explanatory. Item f is calculated from the differential between the product price and the total manufacturing cost times the plant size. Since it was desired to have a rating system that is relative rather than absolute, it was not felt necessary to include such items as insurance, taxes, etc. Item g "payoff," is calculated as research plus investment costs divided by annual earnings.

Setting up such an economic "guesstimate" on a research project that has never been worked on is, of course, a synthetic situation. Therefore, the assumptions set up for the project are most important and in this section are included those crystal-ball estimates as to yields, future sales, size plant, etc.

4. **Secondary benefits to company.**—In this section are included such items as: other problems that would benefit from this research work; advertising value to company; other potential uses of the product developed; possibility of obtaining royalties; byproduct credits not considered in the estimated economics; etc.

5. **Remarks.**—In this section are included: suggested approaches to the solution of the problem; work by others along the same lines; information on any very preliminary exploratory work that may have been conducted by university consultants or our own research personnel; known economics or deficiencies of competitive products or processes.

6. **Chances of project success.**—This is a summary or a consensus of many people as to both the chances of solving the problem technically plus the chances of realizing the economics postulated. Factors which effect this opinion are: amount of work done by others in the field; the degree of optimism or pessimism in the economics setup; the extent of company experience in the field being studied; etc.

These project writeups are, of course, of their very nature just educated estimates. However, every effort is made to base these on the best information available. The following are some of the preparatory steps taken in the preparation of a writeup. First, discussions are held with all of the company marketing, refining, production, and research personnel that in any way contribute information. All company statistical data on sales, sales margins, compounding costs, crude throughputs, refinery yields on similar products or processes, etc., are critically reviewed. Industry statistical data on similar processes or projects are surveyed. These sources include: Mineral Industries Handbook, Stanford Research Institute Economics Handbook, A.P.I. Statistical Bulletins, Tariff Commission Reports, U. S. Department of Commerce Industry Reports, Grease Institute and Asphalt Institute publications, and others. An

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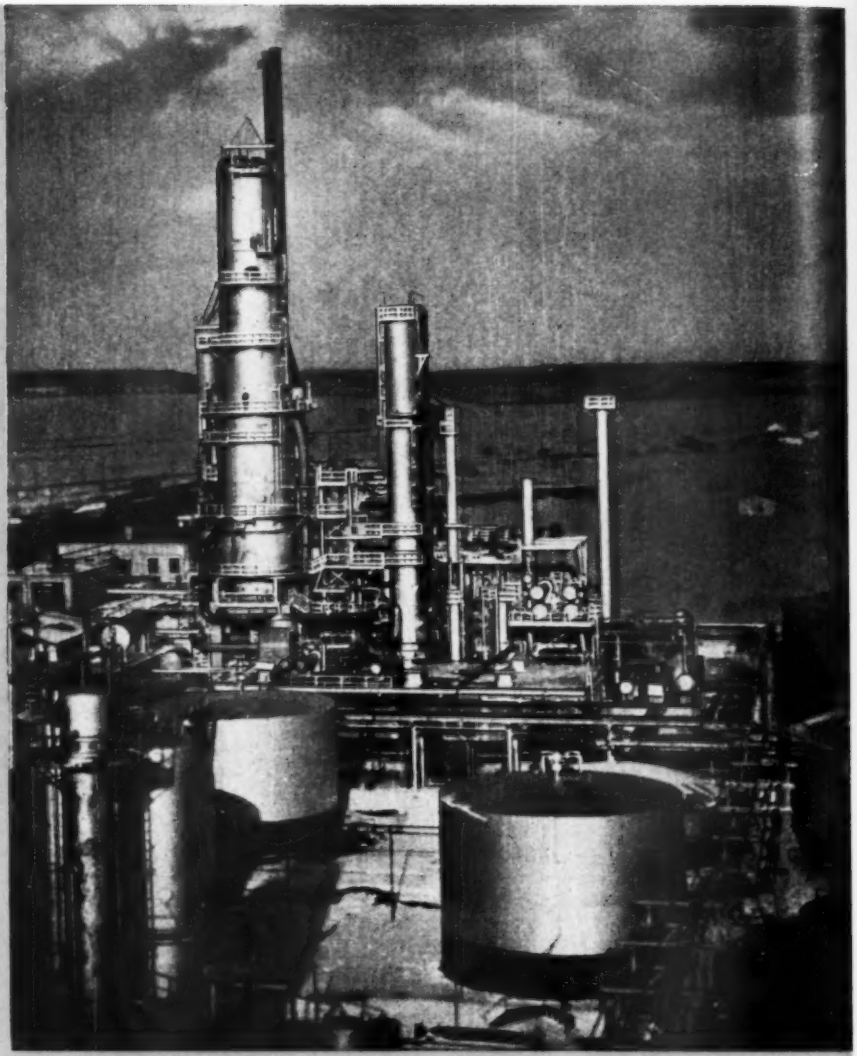

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up-to-date file is kept on company cost data for processing equipment as well as published cost data from periodicals. Very limited preliminary literature and patent searches are made to help establish background on the problem and to reveal information on processes or products that might be a competitive approach.

Of course, those projects on which research work is authorized and under way are continually reevaluated and their writeups firmed up as more experimental and economic information becomes available. Each project is reappraised twice a year or more often if significant information is forthcoming.

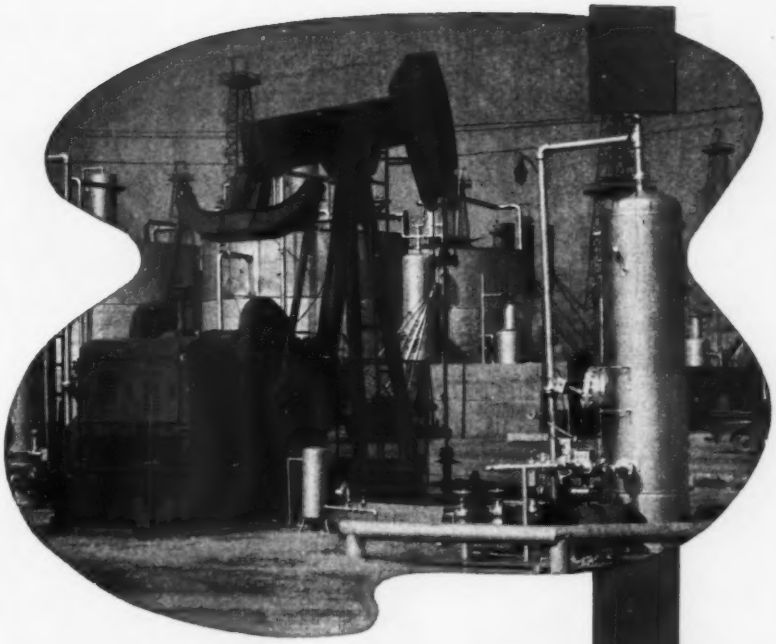
Even after preliminary culling of research suggestions, the number of projects which are formalized into writeups as described are many times beyond the facilities and funds available to work on them. Therefore, the next job is one of setting up a quantitative rating system for selecting those problems to be included in the final research program. Table 2 is such an evaluation rating scheme.

TABLE 2—RESEARCH PROJECT EVALUATION RATING

	Points
Payoff (20 points):	
3.21—6.4 years	2
1.61—3.2 years	5
0.81—1.6 years	8
0.41—0.8 year	11
0.21—0.4 year	14
0.11—0.2 year	17
0.00—0.1 year	20
Chances of success (10 points):	
Poor	2
Uncertain	4
Fair	6
Good	8
Excellent	10
Other pertinent factors (10 points):	
Advantageous company raw-material position	1
Established sales outlet or internal use	1
Maintain business and/or major product	1
Low or reasonable investment (less than $750,000)	1
Chances of yielding royalties	1
Chances of eliminating royalties payments	1
Early realization of research benefits	1
Long-range insurance	1
Moderate research expenditure (less than $250,000)	1
Improvement of product quality	1

Under this system a project can rate a maximum of 40 points. Since payoff is a measure of the economic incentive to carry out the research, it has been allotted the highest number of points, 20. The chances of the research being successful and realizing the predicted payoff and profits for the company is considered of second importance and assigned a maximum of 10 points. Ten other pertinent factors are assigned one point each.

The final steps in the rating scheme outlined consists in giving each project a numerical rating according to the above system. These projects then are listed according to their numerical rating and a program set up based



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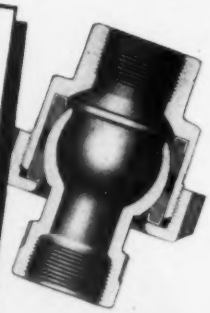
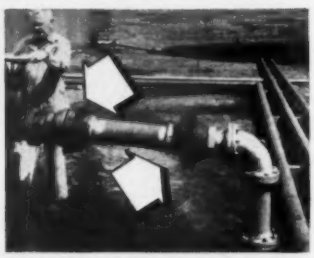


Barco Flexible Ball Joint, Style 7-8—one of many different styles.



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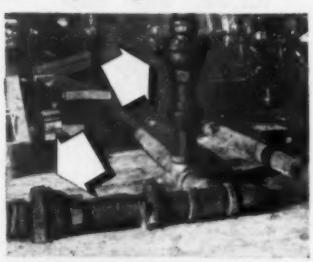

ON MUD PUMPS—Use of Barco Joints saves hours of time in making connections in piping; allows for settling. Safe—no dangerous side thrusts developed by pressure in lines.

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on these ratings and presented to the previously mentioned research committee for consideration. If for any reason, a project of high rating is bypassed, an explanation is given to the research committee. This research committee meets twice a year and critically reviews the research program submitted. If the committee disagrees with the assumptions used in preparing the problem writeup, the problem is reworked and rerated with the suggested changes in the assumption.

The authors feel that they perhaps appreciate the shortcomings of such a rating system more than anyone as they have been subjected to criticisms of the system from many sources for some 2 years now. The following are some of the more pertinent criticisms of such a rating scheme:

1. There is need for a minimum of experimental research information before a problem can be set up in the form outlined.

2. Not enough weight is given to the total dollars return to the company in the rating system. Several small projects of equivalent payoff to one large project, may only bring in a small fraction of the total dollars.

3. Poor guesstimating or lack of information can eliminate many potentially good projects.

4. The plant size selected will, of course, affect the economics. The size chosen is sometimes quite arbitrary.

5. Setting up a research program in this way, may exclude many projects which are needed to protect the company's position in selling its major line of products.

6. Estimates of future potential sales of petroleum products are usually made by the marketing people. It is often said that salesmen can always sell anything they do not have.

As pointed out earlier, projects on which research work has been approved and is under way, are continually rerated by this same system. If the project does not fall too low in its relative standing, it is continued regardless of the fact if there are newer projects that have higher ratings. This is, of course, necessary to maintain continuity in a research program. However, when a project is completed or stopped or deferred, one of the higher-rating projects is then taken on. This does not mean, of course, that when a project's rating has slipped serious consideration is not given to dropping the project. It is probably true that considerable sums of money are wasted on research projects because of the reluctance of research supervisors to stop work on a project under way despite the fact that the economic considerations on which the project was justified have radically changed.

In summarizing, the authors are presenting this rating system as one that has considerable merit, and has

been found to be successful but which has many shortcomings and limitations, which every endeavor is made to continually, if possible, appreciate and rectify.

Aircraft Gas-Turbine Fuels

(Continued from page 219)

standpoint. Studies of availability of fuels can be misleading unless there is a clear understanding of the assumptions made.

In the aircraft industry it is not generally recognized that refining of fuels and lubricants must be a balanced operation. From every barrel of crude a certain amount goes into gasoline, No. 1 fuel, diesel fuel, No. 2 furnace oil, etc. While there is some flexibility in refining procedures to increase the production of one type of fuel in relation to other fuels, this increase must be made at the expense of the others. Also, there are certain limits in how far refining procedures can go in this respect depending upon methods and type of crude processed.

Each refiner obviously wants to operate his units in such a way as to make the greatest profit. If, for example, motor gasoline brings the highest profit then he will cut production of other fuels to the minimum to produce the greatest yield of motor gasoline. Should the demand for JP-3 fuel exceed the supply, the price under normal conditions would increase to the point where it might be more attractive to produce JP-3 fuel. In this case the increase in JP-3 could only be made at the expense of motor gasoline and No. 1 fuel or kerosine.

On Fig. 1 there appears the estimated availability of three grades of turbine fuel, JP-1, JP-3, and a proposed commercial grade. The specifications of these grades appear in Table 2. It will be noted from Fig. 1 that the availability of grade JP-1 is estimated at 6 per cent. This figure probably could be increased somewhat by changes in refining procedures provided the market conditions were favorable. However, two factors are found to impose limitations, freezing point of —76° F. and viscosity requirements. If the military services are to require a quantity of turbine fuel equivalent to 20 per cent of the crude processed, then it is obvious that the availability of JP-1 grade falls short.

The estimated availability of grade JP-3, disregarding the requirements of all other grades of fuel, runs up to 35 per cent from straightrun stocks or in excess of 50 per cent if cracked stocks are to be included. Disregarding all other grades is not a realistic picture, however, because motor gasoline, No. 1 fuel, and kerosine are essential to other branches of military services and to support the civilian economy. Nevertheless, it must not be overlooked that increasing the production of JP-3 grade can come only by cutting into the production of gasoline and middle distillates.

In this respect the military services have shown great foresight in the preparation and adoption of JP-3 (MIL-F-5624) specification. It was the goal of the military services the first of this year to change over the operation of all jet aircraft from JP-1 to JP-3 grades. However, it has not been possible to modify all aircraft

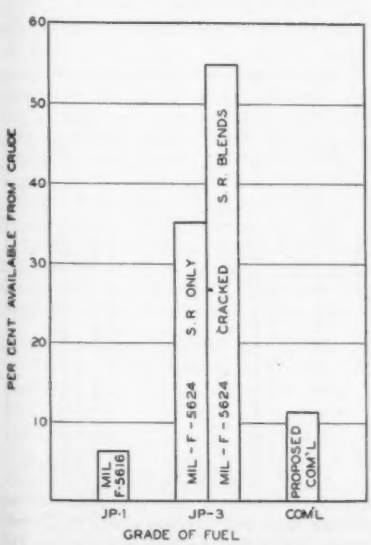

Fig. 1—Availability of aircraft gas-turbine fuels.

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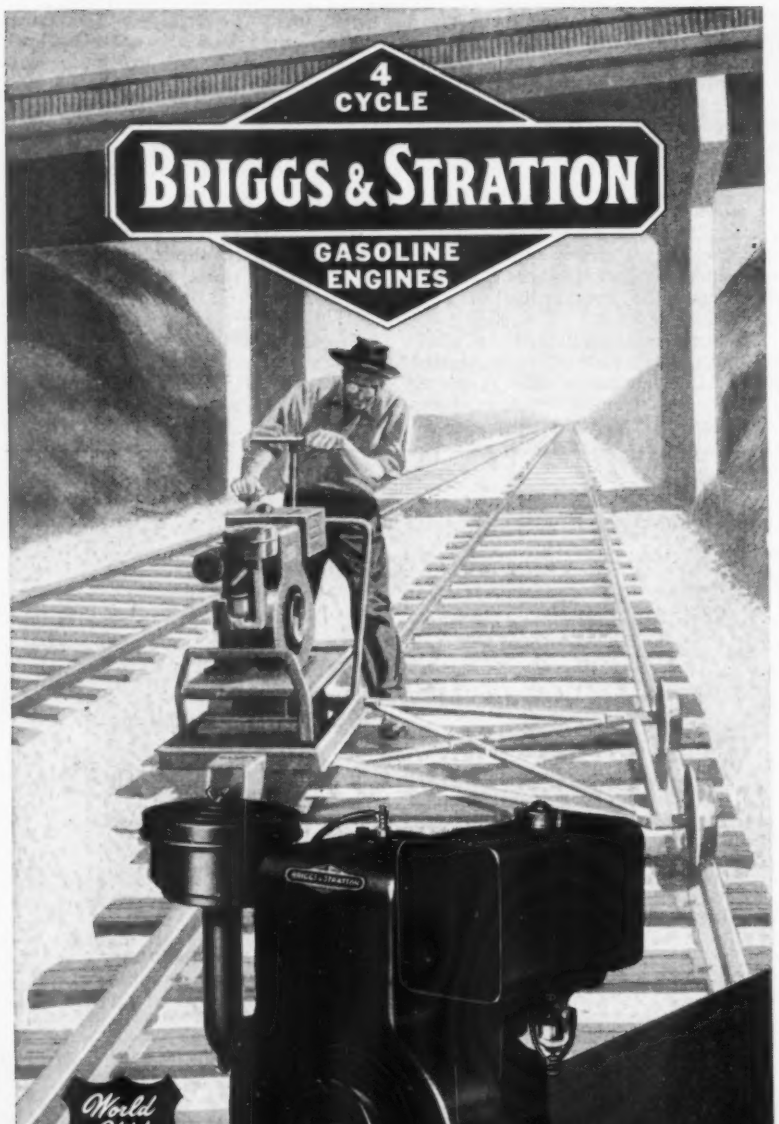

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operating outside of the United States and a limited requirement for JP-1 grade will continue for an indefinite period. Another exception will apply to offshore operations of navy jet aircraft from carriers. These will continue using aviation gasoline probably as long as piston-engine aircraft operate from the same carriers in order to standardize on a single type of aviation fuel.

With commercial transport operations we find quite a different picture with respect to availability. The estimated requirements of domestic civilian operators of grades 100/130 and 115/145 aviation gasoline for year 1951 is 15,000,000 bbl. If all piston engines using these grades of aviation gasoline were to be replaced with turbines at one time, the change would hardly be felt by the petroleum industry because this amount is less than 1 per cent of the overall production. Furthermore, the availability of fuels suitable for commercial operation of the turbine is roughly 15 times greater. It will, of course, take many years to convert a major portion of transport aircraft to turbine power leaving ample time for any slight adjustments in refining operations. Therefore, availability of fuels for commercial operations, using specifications on Table 2, should present no problem whatsoever.

2. Fuel cost.—This is one of the most important factors to the commercial operator. It represents his largest item (over 20 per cent) of direct-operating expenses. Because his rates are fixed by government regulation, there is a ceiling on the maximum revenue per airplane mile. His profit obviously is the difference between total expenses and revenue. However, the important point is the fact that any moderate reduction in operating expenses often results in a substantial increase in profit.

In Fig. 2 it will be noted that Con-

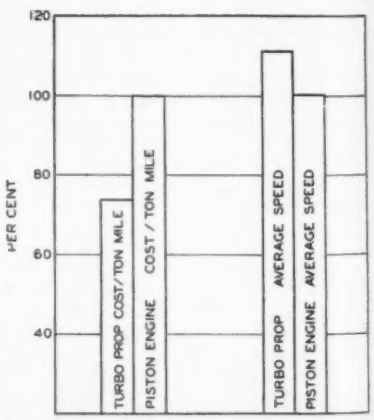

Fig. 2—Comparison between estimated operating costs and average speed of Convair model 240 (piston engine) and Convair Turboliner (turboprop). Distance 400 miles. (Courtesy Consolidated Vultee Aircraft Corp.)

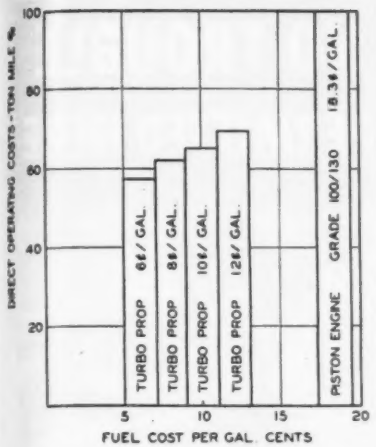

Fig. 3—Comparison between estimated direct operating costs of typical piston engine and turboprop cargo transport. (Courtesy Douglas Aircraft Corp.)

vair estimates a substantial reduction in operating cost of the "Turboliner" powered by two Allison turboprop engines, as compared with the well-known model 240 with two piston engines.

In Fig. 3 a similar example is shown comparing operating costs of turboprop versus piston-engine power on a modern transport. In this case the effect of fuel cost per gallon will be readily seen.

For military operations it is generally recognized that fuel cost is secondary to performance and availability.

3. Flammability—fire hazard.—Third on the list of general requirements is the question of flammability or fire hazard. As previously discussed,[1] there is no such thing as a "safety fuel." Any fuel that will burn in an engine also will burn outside if given the right set of conditions. The principal differences are relative. However, the important factors are ease of ignition and speed with which fire spreads. Service experience and laboratory tests indicate big differences in this respect. It has been demonstrated[2] that at an atmospheric temperature of 100° F. the minimum 10 per cent A.S.T.M. distillation temperature should be approximately 350° F.

Flammability or fire hazard will be one of the most important considerations of commercial operators in their selection of turbine fuels. They will point out that many lives could be saved if fire from ruptured fuel tanks could be prevented following certain landing accidents. In this type of accident the aircraft frequently is drenched with gasoline and fire, which often follows, spreads almost instantly giving passengers little chance for escape.

In addition to the problem of fires following a ruptured fuel tank there are two other conditions that must be considered: first explosion hazard of vapors in the fuel tank, and second, spontaneous ignition of fuel in contact with a hot surface such as a manifold. It is well known that explosion hazard of vapors is a function of both fuel volatility and altitude. At sea-level conditions and temperatures in excess of 100° F. it is possible to have an explosive mixture present in the vapor space with a low-volatility fuel. On the other hand, at subzero temperatures and sea level conditions it is possible to find an explosive vapor in a tank holding aviation gasoline. Essentially the problem appears about the same and only the conditions differ.

Experience fails to show any explosive problem with either aviation gasoline or fuels such as JP-1. Spontaneous ignition tests with fuels in contact with a hot pipe or manifold show only slight differences between fuels. However, these differences are within the limits of experimental error and are not particularly significant. Lubricating oils, on the other hand, have appreciably lower spontaneous ignition temperatures.

Many other factors play important parts in the problem of fire hazard such as design of airframe, location of fuel tanks, and engine-installation details. With the turbine installation it is believed that the location of pumps and lines handling combustible fluids must be kept out of the air-intake duct. Experience has shown that any rupture or leak could fill the incoming air with a combustible mixture that would flash back from the burners and subsequently burn off the forward end of the engine and nacelle. To minimize the problem of fire hazard, careful attention should be paid to some of these design details and to the selection of fuel type.

In military operations we find that considerations of availability and low-temperature starting rule out the use of a less volatile fuel and require a

TABLE 3—FILTER CLOGGING TENDENCY VS. WATER SOLUBILITY
(Fuels saturated with water at storage temperature 50°-59° F.)

Fuel—	Boiling range (°F.)	Solubility of water in fuel at 64° F. per cent by weight	Temp. °F. at which flow dropped by 20 per cent	Temp. °F. at which flow dropped by 50 per cent
Aviation gasoline grade 100/130	111-340	0.007	—8	—15
Kerosine SR 312	316-529	0.006	—13	—20
Kerosine 201	289-504	0.008	—8	—13
Hydrogenated gas oil	363-567	0.003	—38	—44

Source: "Fuels and Lubricants for Aero Gas Turbines" by C. G. Williams, director research, Thornton Aero-Engine Laboratory (Shell).

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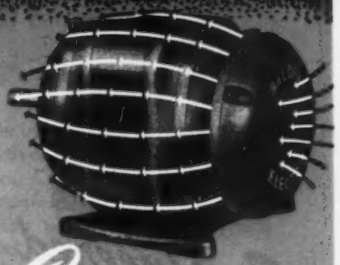

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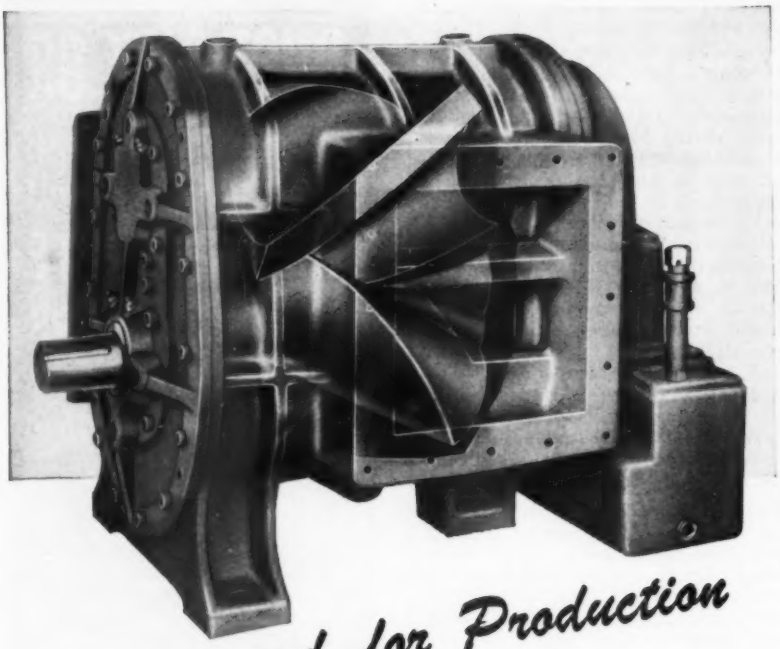

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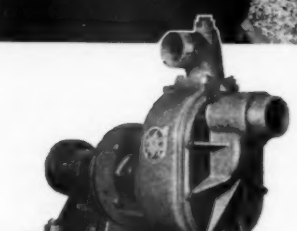

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compromise on a fuel such as JP-3 grade.

4. Low - temperature properties. — The fourth requirement of turbine fuels is its low temperature properties. As we shall see, this is one of the most important factors in aircraft operations. Military operations require starting at atmospheric temperatures of —65° F. In exceptional cases this figure may be revised downward. Experience has clearly demonstrated that —65° F. in military operations is a realistic figure and cannot be compromised without imposing severe limitations.

On the other hand, for a majority of commercial operations it appears that a minimum starting temperature of —40° F. may be satisfactory. At least the present thinking of commercial operators is that they are willing to compromise on this requirement in order to realize advantages of lower fuel cost and reduced fire hazard.

The low-temperature problems can be divided into two parts: first, getting the fuel to the engine and second, obtaining satisfactory starting. Some interesting problems have come up in connection with the first part. Rates of fuel flow to the turbine will run from 1,000 to 1,200 gal. per hr. at full sea-level power in some of the recent models. Due to the design of fuel pumps, a thorough job of filtration is required. Some of these pumps are similar to those found on diesel engines except that they are designed to deliver a steady flow into a common fuel manifold rather than a timed injection to each cylinder.

Filter clogging has presented some serious problems. This clogging may be traced either to ice or wax or both. It is well known that all hydrocarbon fuels dissolve minute amounts of water at higher atmospheric temperatures. This solubility of water in the fuel decreases with a decrease in temperature. A fuel left standing in contact with water or exposed to the atmosphere at 70° F. may dissolve up to an average amount of 0.010 per cent of water by weight. When such a fuel is cooled, water comes out of solution until most of it has dropped out at approximately 0° F.

The solubility of water in fuel decreases also with an increase in molecular weight of fuel and increases with aromatic or olefin content. However, the basic problem remains the same. The reasons for its seriousness in aircraft operations are found in fineness of filtration required, high fuel flows and wide variations of temperature in short periods of time.

In an engine consuming fuel at an average rate of 4,000 lb. per hr. it is possible to collect upwards of 0.4 lb. per hr. of slush ice in the filter from water coming out of solution. This amount is sufficient to plug almost any filter. Thus we find that ice clogging of fuel filters is inevitable if an aircraft was refueled at high atmospheric temperatures, and then flown immediately to high altitudes for a sufficient period of time. A good example showing the effect of water solubility on filter clogging is given in Table 3.

Present solutions are more or less a temporary fix. Addition of a small amount (0.5 to 1 per cent) of isopropyl alcohol to turbine fuel is very effective but has one disadvantage of a limited supply at present to treat all fuels. Another drawback might be the extraction of alcohol from the fuel when stored over water or in contact with free water in storage. Injection at the filter only, to relieve clogging is a more satisfactory solution from a supply point of view but requires extra equipment and something more for the pilot to do. The

TABLE 4—WAX CLOGGING TENDENCY VS. CLOUD POINT (DRY FUELS)

Fuel—	Cloud point (°F.)	Temp. °F. at which flow dropped by 20% drop in flow	Temp. °F. at which flow dropped by 50% drop in flow
Gas oil	+19	+21	+14
Kerosine SR 312	—45	—51	—53
Kerosine 203	—56	—62	—63
Kerosine 201	<—76	<—76	<—76
Hydrogenated gas oil	<—76	<—76	<—76

Source: "Fuels and Lubricants for Aero Gas Turbines," by C. G. Williams, director research, Thornton Aero-Engine Laboratory (Shell).

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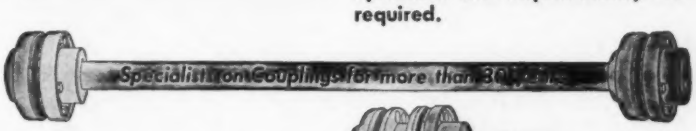

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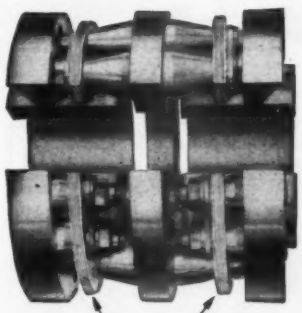

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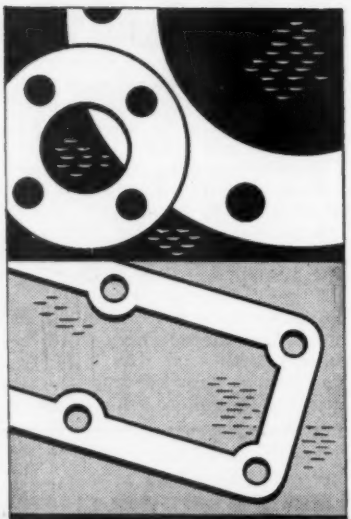

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ideal solution would be to add something to the fuel if it could be made available in large quantities. Several companies are working on this approach at present.

The second factor responsible for filter clogging is wax formation. Middle distillates as a class obviously will present more of a problem than gasoline or JP-1 and JP-3 fuels due to higher freezing points. An interesting point on this problem is the exceptionally good correlation between cloud point and clogging temperature from wax. See Table 4.

In military operations where temperatures of —65° F. may be encountered a freezing point of —76° F. appears reasonable and justifiable. This factor along with availability considerations largely influenced the present requirements of JP-3 fuel specification.

In order that commercial models of turbine-powered transports may utilize low-cost, distillate-type fuels, provisions may be necessary to prevent fuel in the aircraft fuel system from ever reaching extreme low temperatures. Fortunately, latest design practice favors heating wings for deicing purposes which will help the low-temperature problem considerably. Additional sources of heat may be required at or just before the fuel filter.

In the turboprop engine there may be enough heat rejection to the lubricating oil which could be used profitably for heating fuel by means of a heat exchanger. With turbojet engines the heat rejection to lubricating oil may be insufficient for this purpose. Altogether a close control will be required on freezing point. A cloud point may have to be added to specifications for commercial operations.

Once the above low-temperature requirements have been satisfied, it should not be too difficult to meet the starting requirements of the turbine. Engine design and fuel volatility are the important factors here. With fuels having Reid vapor pressures between 5-7 lb. starting usually can be accomplished at —65° F.

5. Volatility—its effect on combustion.—Fuel volatility, as discussed previously[1] governs the evaporation, vapor locking, freezing point, cold starting, flammability, availability, and combustion characteristics. For these reasons volatility or its A.S.T.M. distillation limits must be clearly defined.

Evaporation and entrainment losses of fuel from the vents of aircraft tanks present a serious problem. Vapor locking also might otherwise be a problem if it were not for general use of fuel-booster pumps. All fuels have a "critical altitude" where they begin to boil. This critical altitude also varies greatly with fuel temperature as one might expect. Once the critical altitude is exceeded, boiling gives rise to evaporation and entrainment losses.

With aviation gasoline the critical altitude is approximately 16,000 ft. at fuel temperature of 110° F. The critical altitude of JP-3 fuel is approximately 18,000 ft. at the same temperature. The critical altitude of JP-1 fuel is somewhere in excess of 60,000 ft.

Under severe conditions of climbing to 60,000 ft. altitude, large losses occur with JP-3 fuels partly from evaporation and largely from formation of a persistent foam. This foam carries away entrained liquid fuel in escaping from the fuel tank vents. With aviation gasoline evaporation losses were about the same as JP-3 but the entrainment losses were substantially less because of rapid breakdown of foam.

No vent losses have been observed with JP-1 fuel under similar conditions primarily because the critical altitude of this fuel is in excess of 60,000 ft. Reducing the vapor pressure of JP-3 fuel seems to result in only a small reduction in vent losses because the entrainment losses remained about the same. Different recommendations are being considered at the present time such as pressurizing fuel tanks, reducing foaming characteristics and vapor pressure of fuel. In the meantime it is important that JP-3 fuel be kept as cool as possible prior to flights to extremely high altitudes.

Many data have been accumulated recently concerning the effect of fuel volatility on combustion characteristics. This subject is the one that has been, and is being investigated jointly by petroleum industry, engine builders, military services, and N.A.C.A.[3] (National Advisory Committee for Aeronautics). Present security measures prevent disclosure of many of the details of these tests. However, certain general observations can be made.

Combustor design, inlet-air conditions, fuel-injection system, and fuel volatility have an important bearing on combustion efficiency. The interesting point that is readily apparent is the latitude in types of fuel that the average turbine can handle successfully provided certain adjustments are made to suit each fuel. In contrast, the piston engine will often kick up its heels and show poor performance on one type of aviation gasoline over another. Experience with piston engines during the last war revealed how sensitive some of these engines were to relatively small changes in volatility.

In the early investigations of the effect of volatility on combustion few changes were made on combustors or fuel systems. In those turbines designed originally for operation on aviation gasoline, big differences in performance were found as fuel volatility decreased. In other engines designed for a kerosine type of fuel the use of more volatile fuel obviously gave equally good combustion characteristics and even some re-

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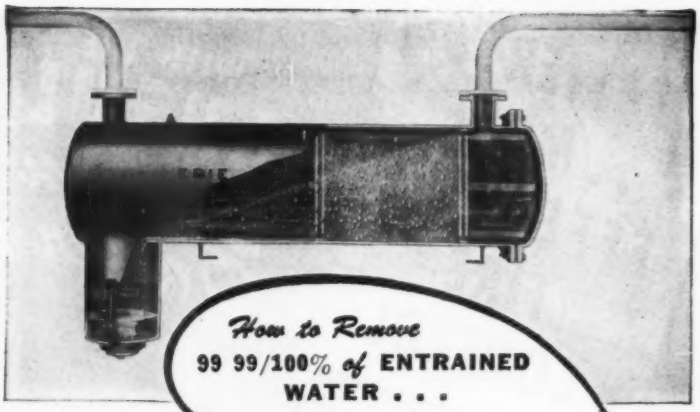

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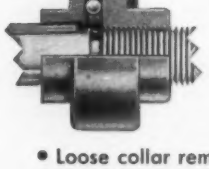

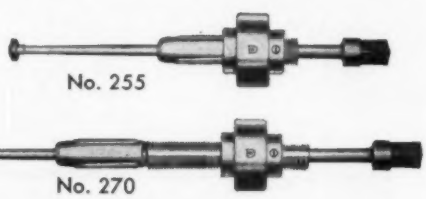

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duction in deposits. The latter type, however, when supplied less volatile fuels than kerosine, such as gas oils, suffered badly in terms of combustion characteristics and general performance.

More attention is now being paid to the design of injectors and these injectors are being matched to the fuel used. Once the optimum combination of injector and combustor design is reached for a given fuel there is no assurance that the same combination will work for another fuel. By adjusting the design factors it is possible to retain approximately the same performance from the combustor over a fairly wide range of fuels. For this reason it is very important for the engine builder to know in advance what kind of fuel an operator expects to use.

6. Stability.—There can be no compromise on the stability requirements of aircraft gas-turbine fuels. This means that fuels must remain stable during some of the most unfavorable conditions of storage. These storage periods in remote areas may often run up to 2 years. In some of these out-of-the-way locations, fuel supplies are moved in once a year during floodstage of streams and rivers. It is not uncommon to find stocks in these places with storage time from 1 to 2 years.

The principal need at this point is a better yardstick for predicting storage stability of less volatile turbine fuels such as JP-3, JP-1, and No. 1 grades. Accelerated gum tests developed for aviation gasoline are not entirely suitable for the above grades of turbine fuel. Recent data seems to indicate that the accelerated aging requirements are too severe. Also, the present air-jet gum values are much higher than steam-jet gum values (500° F.) and the former shows neither good correlation nor good reproducibility. This problem requires further investigation and it appears that some revisions may be made in present gum-test methods when more ade-

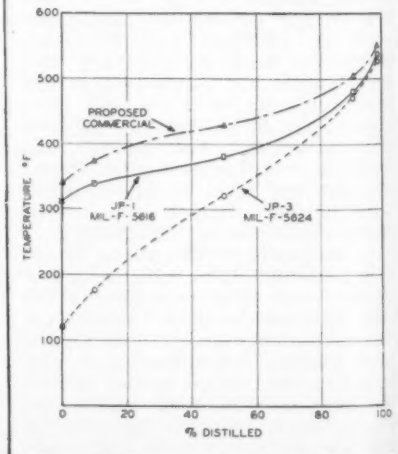

Fig. 4—Distillation curves of typical aircraft gas-turbine fuels.

quate means of measuring stability are available.

7. Heating value.—The turbine engine, at the present time, suffers one principal disadvantage of higher fuel consumption when compared with the piston engine. This disadvantage already has diminished somewhat by recent improvements in fuel consumption. In those installations where combustion efficiency has not changed it has been demonstrated that range of an aircraft bears a direct relationship to heating value on a volumetric basis.

Several important factors should be kept in mind. First, the design of modern aircraft is such that both military and commercial types are volume limited more than weight limited. This means that the problem is finding sufficient space within the wing or fuselage envelope for fuel tanks. Therefore, the heating value on a volumetric basis is more significant than on a weight basis. Second, as we increase the boiling range the heating value on a weight basis decreases and conversely the heating value on a volumetric basis increases. Third, petroleum offers the highest heating values at the lowest price of any fuels suitable for the aircraft turbine. Fourth, after meeting all of the other requirements previously discussed, there is little that can be done about it anyway.

The real function of heating value is to aid in the selection of the most suitable grade of fuel, such as the choice of No. 1 grade fuel oil in place of aviation gasoline (see Table 5 and Fig. 5). The real drawback of a heating-value requirement in a specification comes when a specification writer selects a number at random that is unduly restrictive. Therefore, it may be concluded that heating value should not be part of the quality controls in a turbine fuel specification.

8. Odor.—The eighth requirement on Table 1 is odor. All turbine fuels should have a satisfactory odor. A mercaptan content of 0.005 per cent is now required in both JP-1 and JP-3 specifications. The purpose is twofold, first odor and second to prevent deterioration of the polysulfide type of synthetic rubber (Thiokol) used in parts of present fuel systems by mercaptan sulfur compounds. In some quarters the "doctor test" requirement is considered more stringent than necessary. By specifying mercaptan sulfur, various other sweetening operations can be used and is regarded as preferable for many refining operations.

TABLE 5—COMPARATIVE HEATING VALUES OF TURBINE FUELS AND AVIATION GASOLINE

	B.t.u./lb. net value	Change (%)	B.t.u./gal. net value	Change (%)
Aviation gasoline—grade 100/130 (MIL-F-5572)	19,050	...	110,900	....
Turbine fuel—grade JP-3 (MIL-F-5624)	18,690	—2	122,680	+11
Turbine fuel—grade JP-1 (MIL-F-5616)	18,530	—3	126,700	+14
Turbine fuel—proposed commercial grade (Fuel Oil No. 1)	18,520	—3	127,000	+15

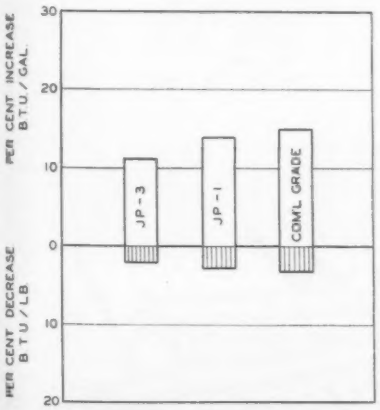

Fig. 5—Comparative heating values of turbine fuels and aviation gasoline.

Fuel Specifications—Summary

From the foregoing requirements everything points towards two types of turbine fuels, one for military and

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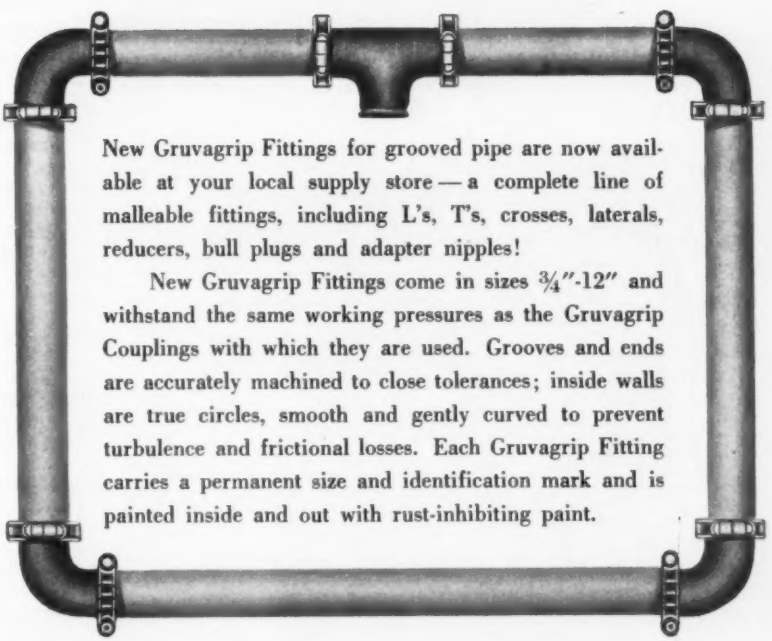

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Croloy 2	(2% Cr, ½% Mo)
Croloy 2¼	(2¼% Cr, 1% Mo)
Croloy 3-M	(3% Cr, 1% Mo)
Croloy 5	(5% Cr, ½% Mo)
Croloy 5-Si	(5% Cr, ½% Mo, 1½% Si)
Croloy 5-Ti	(5% Cr, ½% Mo, ½% Ti)
Croloy 7	(7% Cr, ½% Mo)
Croloy 9-M	(9% Cr, 1% Mo)
Croloy 18-8-S	(18% Cr, 8% Ni)
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Croloy 25-20	(25% Cr, 20% Ni)

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the second for commercial or civilian operations.

An impartial appraisal of all the factors involved in the selection of fuel for military operations at present would indicate that JP-3 is the most practical. With emphasis placed upon availability, starting at —65° F., and good combustion characteristics over a wide range of altitude conditions, the specification for grade JP-3 appears a good compromise. At the same time, evaporation and vapor locking will become a greater problem as rates of climb go higher and higher and as temperatures due to compressibility in supersonic aircraft become troublesome. For the new crop of aircraft we may find a different compromise in fuel specification necessary, by reducing vapor pressure.

For commercial operations the situation at the moment appears quite different. Here we find the emphasis placed on low fuel cost, minimum flammability, and performance. The demands on availability are small compared with the military. Also, lowest starting temperatures will not approach the military for most operations. In addition, altitudes of operating commercial models of turbine aircraft will be considerably lower and the atmospheric temperatures encountered less severe.

Finally, the question arises as to what specific fuel is the best choice for the commercial aircraft gas turbine. Neither aviation gasoline nor JP-3 fuel will meet the requirements. JP-1 grade would be a good choice except that it may not be in production by the time commercial-turbine operations begin. It could be made available if a sufficient demand arises, however, and subject to limitations already mentioned.

An illuminating grade of kerosine likewise would satisfy most of the requirements except for the fact that it is disappearing from some market areas. Stocks of kerosine, therefore, would not be readily available. Review of tests on over 250 samples of middle-distillate fuels taken from all parts of the United States indicates that the No. 1 grade of fuel oil comes the closest to meeting the general requirements of turbine fuel for commercial operations.

Assuming that the present level of quality of the No. 1 grade is maintained, this appears to be the most logical choice. This grade of fuel is also identified as No. 1 burner oil and stove oil. On the West Coast different specifications are in general use and a fuel of this quality is generally known as stove oil. Also, it should be recognized that the No. 1 grade of fuel or stove oil is sold by some distributors as kerosine.

The proposed specifications for the commercial turbine fuel (No. 1 grade) can be met readily by a majority of the No. 1 fuel oils now marketed. The typical or average distillation curves appear on Fig. 4.

If engine builders and airframe companies design turbines and aircraft to operate successfully on this type of fuel, the commercial operators then could realize a number of advantages of wide distribution and low price that could not be realized if special fuels are to be supplied.

Acknowledgment

The author wishes to acknowledge his appreciation to the Munitions Board, Petroleum Division, U. S. Air Forces, and Navy Bureau of Aeronautics; also, to various aircraft and engine manufacturers, particularly General Electric Co., Allison Division, Consolidated Vultee Aircraft Corp., and Douglas Aircraft Corp., and the domestic airlines and members of the Refining Department of The Texas Co. for their contributions and helpful suggestions used in this paper.

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2. Experiments conducted by The Texas Co., Beacon Laboratories, on "Inflammability of Aviation Fuels."

3. "Effect of Fuel Properties on the Performance of the Turbine Engine Combustor" by Gibbons and Jonash NACA Lewis Flight Propulsion Laboratory. Paper given at A.S.M.E. November 29, 1948.

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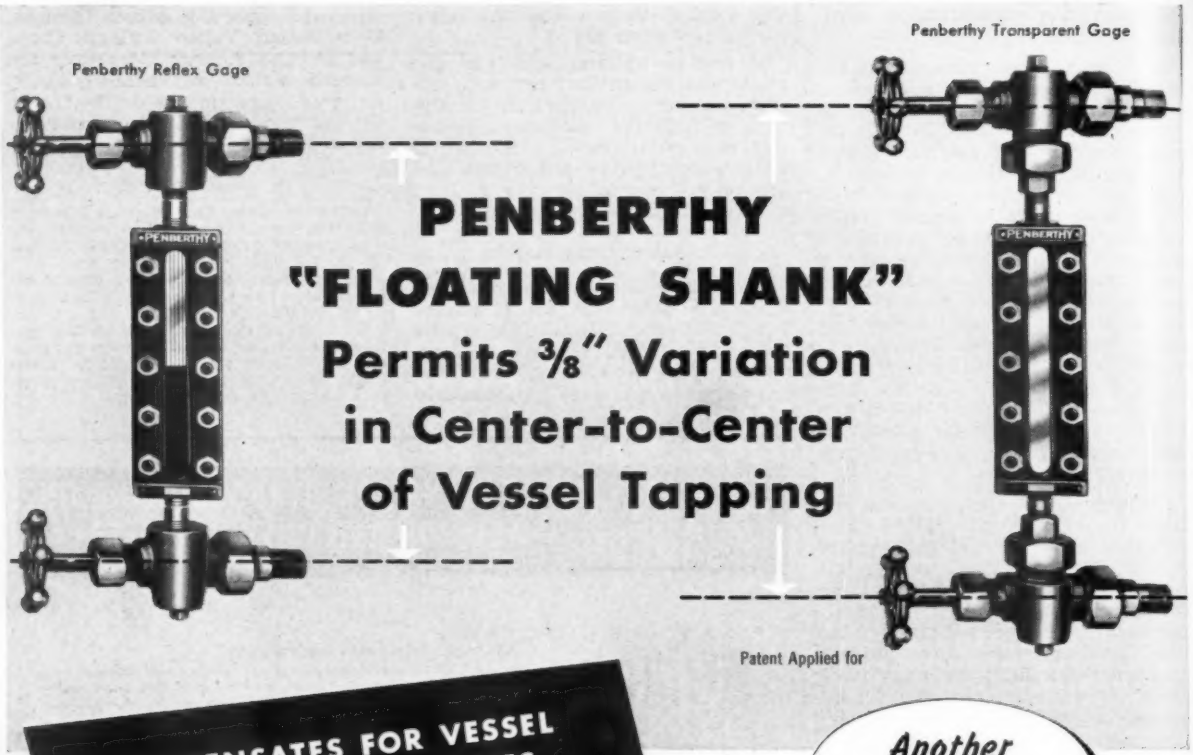

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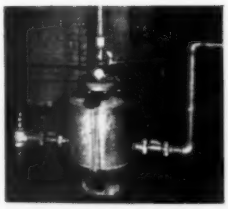

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This feature isn't a contest, no prizes will be given. Moreover, some people are going to get higher scores on some classifications, and make a lot of misses in others. But this quiz program has been drawn in accord with The Oil and Gas Journal's long-standing broad policy—to *broaden* and assist its readers in all phases of the petroleum industry, not to *restrict* them to narrow limits.

ABOUT THE POSTCARD.—The quiz program at hand is on petroleum refining. Besides occasional ones like this, would you like to see others on: EXPLORATION-GEOLOGY; DRILLING AND COMPLETION; OIL AND GAS PROD. & PIPE LINES? If so, please tell us, via the accompanying prepaid postcard.

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THE JOURNAL'S "REFINING QUIZ"

Prepared by Editorial Staff of The Oil and Gas Journal in collaboration with
Prof. G. L. Farrar
Chemical Engineering Department
Texas A. & M. College

Can You Run a Refinery?—This test is to help Journal readers check their knowledge of a variety of the practical engineering and operating problems that are involved in modern petroleum refining. This miniature "refresher course" covers most of the important classifications involved.

Procedure

Work sheets are provided on page 297. There are three altogether; cut one out for yourself, or others, if you have one or more friends that are going to engage in this quiz refresher course checkup with you. Use these answer sheets in checking your replies and scoring—don't make marks at all opposite the questions. After taking the test, the correct answers are printed on page 300, where you can check your replies.
Remember—no peeking. This refresher course test is given under the Honor System.

How to Score

For each test question, five possible answers are given. From the five possibilities, the correct answer should be selected and its number placed on the answer sheet next to the number of that question. Example:

Question No. 0—In the modern petroleum refinery, the initial processing of the crude as received usually is:

1. Atmospheric distillation
2. Thermal cracking
3. Solvent dewaxing
4. Catalytic cracking
5. Propane deasphalting

The correct answer for Question 0 is **atmospheric distillation** and the number 1 has already been placed at the right of 0 on the answer sheet. All of the questions on these pages are based on material which has appeared in The Oil and Gas Journal, mostly during the past year. For convenience the exact Journal references are given on the answer sheets.

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INTRODUCTORY

Question No. 1

Thermal cracking operations are employed in nearly all refineries. The main purpose of thermal cracking is:

1. Production of asphalt.
2. Increase in yield of heavy gas oil.
3. Improve lube stock.
4. Increase the yield and quality of gasoline and lighter components.
5. Remove corrosive sulfur compounds.

Question No. 2

A number of improvements have been made recently in refining motor oils. A very desirable property in a motor oil is:

1. High viscosity index.
2. Low viscosity index.
3. High content of suspended carbon.
4. High sulfur content.
5. High volatility.

Question No. 3

All but one of the following materials may be blended into motor gasoline to **increase** its octane number:

1. Tetraethyl lead.
2. Thermally cracked gasoline.
3. Catalytically cracked gasoline.
4. Natural gasoline.
5. Refinery straightrun gasoline.

Question No. 4

A well-known refinery stock has a 375°-400° F. end point. This stock is:

1. Lightweight lube oil.
2. Gas oil.
3. Kerosine.
4. Motor gasoline.
5. L.P.G.

Question No. 5

Butane is often blended into motor gasoline. Care must be taken not to get too much butane since:

1. Octane number would be reduced.
2. End point would be increased unduly.
3. Reid vapor pressure would be too high.
4. Reid vapor pressure would be too low.
5. Increase in TEL content would be required.

Question No. 6

In the atmospheric distillation of crude oil, the stock from which fuel oil will be manufactured is:

1. Taken overhead.
2. Removed as bottoms from the column.
3. May be recovered as the most volatile fraction.
4. Returned to the upper part of the column as side reflux.
5. Removed from the column as a vapor.

Question No. 7

All but one of the following determinations are run on lubricating oil:

1. Octane number.
2. Flash point.
3. Fire point.
4. Pour point.
5. S.U.S. viscosities.

Question No. 8

The production of diesel fuel is becoming of great importance to the refiner. **All but one** of the following are characteristics of a good diesel fuel:

1. Low octane number.
2. High cetane number.
3. High octane number.
4. It is less volatile than gasoline.
5. It is more volatile than lubricating oil.

Question No. 9

If the temperature of thermal cracking is held too high, one of the following results:

1. Yield of gas and butane and butylene is increased.
2. Rate of coke deposit is decreased.
3. Yield of gas and butanes and butylenes is decreased.
4. No change in product yields results.
5. A large portion of the gas oil charge is unconverted.

Question No. 10

All but one of the following statements apply to the primary distillation of crude oil:

1. Stripping steam is usually used.
2. The feed is heated to a high temperature and flashed into the column.
3. Side reflux is usually employed.
4. One or more side streams may be removed from the column.
5. Reboiler heat is provided by steam in enclosed coils.

Question No. 11

Periodic testing is required to check the characteristics of the various petroleum products. One of the following tests is not ordinarily made in routine testing of petroleum:

1. A.S.T.M. distillation.
2. Aniline point.
3. Conradson carbon residue.
4. Infrared analysis.
5. Pour-point determination.

Question No. 12

Following the various processing steps to produce gasoline, a gasoline stabilizer may be used. In this unit:

1. Light ends are removed from gasoline.
2. Butane is added to gasoline.
3. Kerosine is removed from gasoline.
4. Gasoline is separated from lube oil fractions.
5. TEL is added.

PROCESSING

Question No. 13

Returns from The Oil and Gas Journal's 1951 survey of refineries show the total daily crude-oil input capacity of operating plants in the United States to be about:

1. 5.00 million barrels
2. 6.75 million barrels
3. 5.50 million barrels
4. 10.00 million barrels
5. 7.95 million barrels

Question No. 14

Catalytic cracking units are incorporated into the processing layout of a number of United States operating plants of 100 bbl. daily capacity or more. One of these figures indicates the percentage of the operating refineries which contains these facilities:

1. 25 per cent
2. 10 per cent
3. 50 per cent
4. 75 per cent
5. All

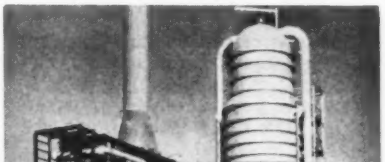
Question No. 15

A somewhat smaller number of United States refineries of 100 bbl. daily capacity or more are equipped with alkylation facilities. The percentage of operating plants prepared to make alkylate is one of these:

1. 2 per cent
2. 40 per cent
3. 60 per cent
4. 25 per cent
5. 10 per cent

Question No. 16

The unit pictured here may be recognized as a:



1. Houdry fixed-bed catalytic cracking process.
2. Vacuum pipe still.
3. Thermal cracking unit.
4. Dubbs unit.
5. Petro-Chem heater.

Question No. 17

The coking of hydrocarbon oils has long been practiced primarily for the purpose of:

1. Increasing yield of heavy gas oil.
2. Increasing yield of isobutane.
3. Increasing yield of cracked gasoline and residual-fuel production.
4. Improving fuel-oil quality.
5. Reducing kerosine production.

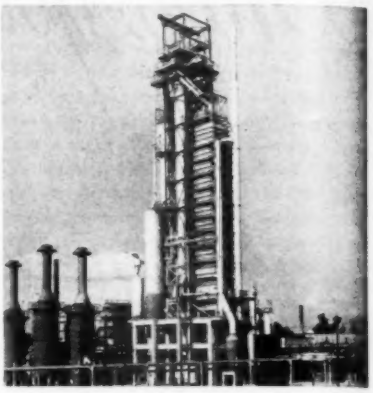
Question No. 18

Thermal cracking processes are among the best known and most useful in the petroleum refining industry. **All but one** of the following statements are true of thermal cracking processes:

1. Good gasoline may be produced from every variety of charging stock.
2. Butylenes and propylene are produced.
3. Distillates are withdrawn as sidecuts.
4. The catalyst used in this process is of the "moving bed" type.
5. Gas recovered from the process contains substantial amounts of materials used to produce polymer gasoline.

Question No. 19

The unit pictured here may be recognized as:



1. Fluid catalytic process.
2. Houdriflow process.
3. T.C.C. process.
4. Crude topping unit.
5. Precision fractionator.

Question No. 20

A process in wide application for primary distillation of crude oil is the two-stage atmospheric and vacuum distillation process. The main reason for the use of vacuum in the second stage is to:

1. Decrease pressure drop in this section.
2. Reduce pumping requirements.
3. Provide better control of the operation.
4. Permit vaporization of heavy stocks at lower temperatures and thereby reduce cracking.
5. Improve steam stripper operation.

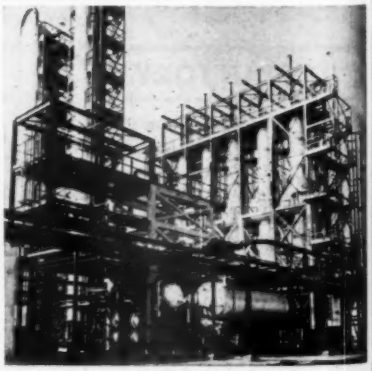
Question No. 21

These processes for catalytic cracking oil stocks are in current refinery use. Of these, one employs the fixed-bed principle:

1. T.C.C. process.
2. Fluid catalytic cracking process.
3. Cycloversion catalytic cracking process.
4. Houdriflow catalytic cracking process.
5. Suspensoid catalytic cracking process.

Question No. 22

This unit could probably pass for any one of several processes, but it is most probably a:



1. Propylene poly-gasoline process.
2. An atmospheric crude topping still.
3. A fluid catalyst unit regenerator.
4. Desalting process.
5. Water-treating unit.

Question No. 23

The following modern refinery processes provide for the removal of sulfur compounds from liquid and/or gas streams. One of these processes uses solutions of amines for scrubbing hydrogen sulfide from gas or liquid streams:

1. Unisol.
2. Girbotol.
3. Tannin solutizer.
4. Mercapsol.
5. Perco.

Question No. 24

Processes involving purification of lubricating oils by solvent extraction are becoming more and more important in the refining industry. **All but one** of these processes are of this type.

1. Hypersorption.
2. Furfural refining process.
3. Propane deasphalting.
4. Propane dewaxing.
5. Solvent dewaxing.

Question No. 25

In 25 years, the production of chemicals from petroleum has increased from a negligible amount to a very significant portion of the total chemical production from all sources. Today raw materials (exclusive of aromatics) are produced from petroleum for the synthetic organic chemicals industry in the amount of:

1. 100,000 tons yearly.
2. 500,000 tons yearly.
3. Approximately 2,000,000 tons yearly.
4. 50,000 tons yearly.
5. Approximately 10,000,000 tons yearly.

Question No. 26

Ethylene is a very important raw material for organic chemicals manufacture. A most important chemical ultimately produced from ethylene and benzene is:

1. Acetone.
2. Butadiene.
3. Xylene.
4. Toluene.
5. Styrene.

Question No. 27

In the utilization of propylene in the petrochemical industry, **all but one** of the following materials are produced in quantity:

1. Isopropyl alcohol.
2. Acetone.
3. Vinyl chloride.
4. Glycerin.
5. Acrylic acid.

Question No. 28

The butylene-rich streams produced in refineries are used to large extent in polymerization reactions. One of these polymerization products **is not** made from butylenes:

1. Butyl rubber.
2. GRS rubber.
3. Nitrile rubber.
4. Poly isobutylene.
5. Poly styrene.

Question No. 29

The petroleum refining industry is called on to process greater and greater quantities of crudes having high salt content. **All but one** of the following problems are encountered in processing crudes containing appreciable salt:

1. Corrosion of processing equipment.
2. Plugging of exchangers and furnace coils resulting from salt deposition.
3. Emulsification of salt water and the crude oil.
4. Contamination of residual products.
5. Contamination of cracked motor gasoline.

Question No. 30

With the current stepped-up demand for aviation gasoline, isomerization and isoforming processes are again assuming great importance in refining operations. The catalyst used in a number of "iso" processes is:

1. Alumina-chromic oxide.
2. Alumina-silica.
3. Aluminum chloride, promoted by HCl.
4. Ethanol amine.
5. Vanadium pentoxide.

Question No. 31

The United States is depending more and more on crude supplies from foreign countries for refinery operations. Of these countries the one supplying the greatest amount of crude is:

1. Saudi Arabia.
2. Colombia.
3. Mexico.
4. Venezuela.
5. Kuwait.

Question No. 32

Foreign crude is currently refined in greatest volume in one of these United States areas:

1. New York.
2. Philadelphia.
3. Beaumont-Port Arthur.
4. Baltimore.
5. Boston.

Question No. 33

New installations of delayed-coking units have recently been made. In one of these units employing hydraulic decoking, **all but one** of these statements is true:

1. Furnace-coil outlet temperatures run above 900° F.
2. Decoking water delivery pressure may run as high as 1,900 psig.
3. Based on a 10,000-bbl.-per-day feed, approximately 7,500 bbl. of gasoline and gas oil is obtained.
4. Reduced crude is charge stock.
5. Sulfur content of the charge stock must be well below 1 per cent.

Question No. 34

Recent improvements have been made in the sulfuric acid alkylation process. These improvements are based on:

1. A completely redesigned reactor section.
2. A new catalyst.
3. Better feed stocks.
4. More precise fractionation of product alkylate.
5. A better control system.

Question No. 35

Production of fuels for our fighting forces is receiving the increasing attention of petroleum refiners. From the standpoint of the military, possibly the most important requirement for these fuels **as a group** is:

1. High octane number.
2. The number of different types of materials to be transported should be kept to an absolute minimum.
3. Gum and varnish content must be kept to a minimum.
4. Uniform boiling-point range.
5. A high percentage of straightrun fractions.

Question No. 36

Flexibility in product balance at the present time is such that with proper equipment the petroleum refiner may vary his gasoline production from total crude in the range:

1. 20-25 to 60-70 per cent.
2. 40 to 50 per cent.
3. 40 to 60 per cent.
4. 35 to 80 per cent.
5. 0 to 100 per cent.

Question No. 37

Consumption of petroleum products in the United States has progressively increased since 1925. In 1950 the consumption was approximately:

1. 5,000,000 bbl. per day.
2. 4,500,000 bbl. per day.
3. 6,000,000 bbl. per day.
4. 7,500,000 bbl. per day.
5. 10,000,000 bbl. per day.

Question No. 38

The proportion of catalytically cracked gasoline in the total production of cracked motor gasolines has increased steadily since 1938. Of the total production in mid 1950, catalytic motor-gasoline production amounted to approximately:

1. 10 per cent of the total.
2. 20 per cent of the total.
3. 30 per cent of the total.
4. 35 per cent of the total.
5. 40 per cent of the total.

Question No. 39

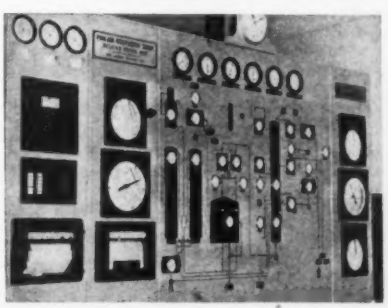
Some of the largest refining operations in the United States are conducted in the Gulf Coast area. **All but one** of the following statements are true of this area:

1. Daily crude run is greater than 1,500,000 bbl. daily.
2. More than 31 per cent of the total daily United States crude run is processed.
3. More than 45 per cent of the total United States alkylate is produced.
4. 50 per cent of the total United States capacity rating is located here.
5. Nine Gulf Coast refineries produce about 35 per cent of the total United States output of alkylate.

INSTRUMENTATION

Question No. 40

Installation of instrument units similar to this represents a current trend

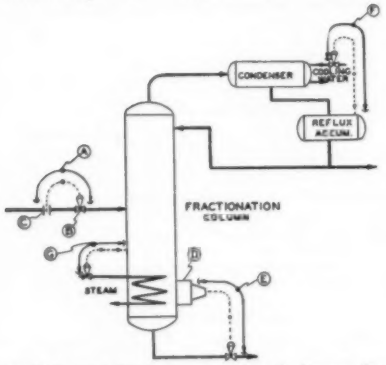


in instrumentation. Pictured here is a:

1. Ratio control unit.
2. Time-cycle control installation.
3. Graphic panel.
4. Limit control unit.
5. Metered control system.

Questions No. 41-44

On this diagram, identified in the statements below, are schematically represented some of the elements necessary for fractionator control.



Write on the answer sheet (opposite the number for each question) the letter on the diagram which correctly describes the statements below:

Question No. 41

This portion of the control system represents a liquid level indicator.

Question No. 42

A pressure control setup is depicted on this portion of the diagram.

Question No. 43

This schematic representation is of an orifice meter.

Question No. 44

A temperature control system is represented by this section of the flow sheet.

Question No. 45

Proper design and maintenance of an instrument air system is of utmost importance to instrument performance. **All but one** of the following statements are true concerning the instrument air system:

1. The air should be clean and dry.
2. Use of the general yard or utility air system is satisfactory if supplied in sufficient quantity.
3. A standby compressor with automatic cutin should be provided.
4. Proper sizing is important.
5. The supply header should operate at 30-35 psig., with the compressor discharge at 40-45 psig.

Question No. 46

The mode of control, or type of control action, should be carefully selected with the requirements of a given process in mind. A process in which large load changes are expected to occur should have one of the following modes incorporated in its control action:

1. Two-position.
2. Proportional.
3. Floating.
4. Rate or derivative.
5. Proportional-rate.

Question No. 47

Proper functioning of automatic instruments is impossible without correct controller adjustment for the process at hand. In proportional or throttling control, if the throttling range or proportional band is too narrow:

1. Excessive cycling of controlled variable occurs.
2. No change is noticed, beyond a certain point.
3. Greatest deviation of controlled variable occurs.
4. The amplitude of deviation from control point is excessive.
5. Reset action is approximated.

Question No. 48

Rate or derivative action is incorporated in a large number of controllers. One of the main reasons for using this mode in a controller is that it improves control quality in a process where:

1. Small load changes are expected.
2. Large load changes are expected.
3. Significant lags and dead times are present.
4. Fluid flow is to be metered.
5. Reset action is not desired.

Question No. 49

Good design and operation of the control valve are quite important factors in proper functioning of the controller system. The logarithmic valve characteristic sometimes used with the proportional-reset (or other complicated control modes) may be obtained by using this type of inner valve:

1. Bevel plug.
2. V-port plug.
3. Needle plug.
4. Percentage parabolic plug.
5. Cone plug.

Question No. 50

Frequently in process instrumentation it is desirable to locate the controller a considerable distance away from the measuring element. In these cases a transmitter is required in pneumatic systems. When using a pneumatic transmitter:

1. No measurable transmission lag exists.
2. The transmitter should be installed on the control panel.
3. The receiver should be located close to the transmitter.
4. Good response can be obtained with air-transmission tubing lengths of 500 to 600 ft.
5. Capillary bulb thermometers should not be used.

Question No. 51

Consideration of process lag is a vital factor in the proper application of control systems. **All but one** of the following lag times may be appreciable:

1. Supply-side capacity lag.
2. Transfer lag.
3. Demand-side capacity lag.
4. Distance-velocity lag.
5. Controller lag.

Question No. 52

All but one of the following statements concerning process lag are true:

1. Fluid flow processes contain little or no transfer lag.
2. Transfer lag is rarely appreciable in temperature-control systems.
3. Dead time merely displaces the process reaction curve; it does not alter its shape.
4. Capacity lag is usually greater for temperature control than for pressure control.
5. Appreciable process lag causes retardation of process recovery from an upset due to load change.

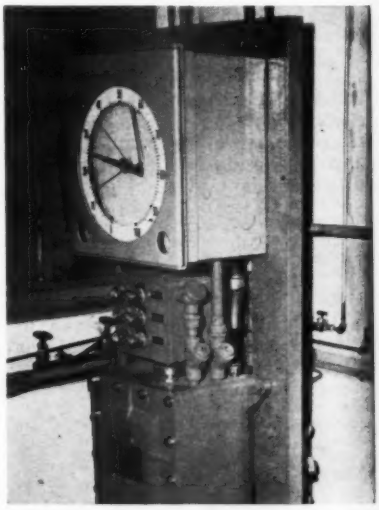
Question No. 53

When two variables must be controlled to maintain a definite relationship between them, a ratio or metered control system is employed. **All but one** of the following statements apply to a ratio control system:

1. The primary element is ordinarily a transmitter.
2. A fixed ratio exists between the magnitudes of the two variables.
3. This is an interlocked control system.
4. The set point or positioning unit of the ratio controller is continuously set by impulse from the primary element.
5. No fixed ratio exists between magnitudes of master and secondary variables.

Question No. 54

Considerable thought is currently being given to the continuous analysis and control of process stream compositions. The instrument pictured



here is a continuously recording instrument. Its principle of operation is based on continuous:

1. Infrared absorption.
2. Ultraviolet absorption.
3. pH indication and control.
4. Analytical fractionation.
5. Carbon dioxide analysis and control.

MAINTENANCE

Question No. 55

Housekeeping is an extremely important part of maintenance. Most of the housekeeping around units is done by the unit operators. However,

special maintenance crews should be called in to:

1. Keep the floors clean from oil spills.
2. Maintain valve packings in proper condition.
3. Pick up trash and rags around the unit.
4. Paint equipment as necessary.
5. Rake the graveled areas around the units.

Question No. 56

Maintenance is important in all refining plants, but it is more important in the small refinery, due to:

1. Lack of standby equipment.
2. Small size of equipment.
3. Smaller labor force.
4. More complicated processing steps.
5. Poor organizational setup.

Question No. 57

Rigid housekeeping standards are a requisite in a well-run refinery. **All but one** of the following statements apply to good housekeeping practice:

1. Housekeeping is tied in closely with safety.
2. Good housekeeping takes time away from operating procedures and therefore may tend to lower product quality.
3. Good housekeeping improves the morale of the workers.
4. A clean plant aids in obtaining new customers.
5. Hazardous situations are more easily spotted.

Question No. 58

A good refinery salvage program is a necessary part of maintenance. One of the following statements concerning the salvage operation is **not** true:

1. Considerable money saving is accomplished.
2. It provides an orderly way of disposing of replaced material.
3. Housekeeping is generally improved.
4. Salvaged and repaired equipment may seldom be reused for important refinery service.
5. The salvage operation is used to recover and recondition equipment to be reused in many refinery applications.

Question No. 59

The scheduled shutdown (or turnaround) of a unit is an example of preventive maintenance. **All but one** of the following statements are true of this type shutdown:

1. Long-range planning is necessary several weeks before the shut down.
2. If the unit has been inspected previously, individual manpower assignments are not necessary.
3. Replacement material should be ordered well in advance.
4. Operating personnel should be assigned definite jobs.
5. Special process experts should at times be called in.

Question No. 60

The turnaround inspection is accomplished by several different means. However, one of the following methods is **not** usually used:

1. Visual inspection.
2. Hammer testing.
3. Pressure tests.
4. Measuprements of various wall thicknesses.
5. Chemical tests.

Question No. 61

There are several reasons why the turnaround inspection of a refinery unit is important. Probably **the most far reaching** of these is:

1. Determination of corrosion at danger points.
2. Obtaining accurate records in order to predict unit replacements.
3. Determination of defects reducing the efficiency of operation.
4. Determination of safe operating conditions.
5. Reconditioning of relief valves and other safety equipment.

Question No. 62

Cooling-tower maintenance is necessary to insure a continuous, adequate supply of cooling water. It is recommended that a continuous blow down be employed to:

1. Reduce algae formation.
2. Control pH of the cooling water.
3. Reduce salt content of the cooling water.
4. Reduce chlorine requirements.
5. Decrease required cleaning.

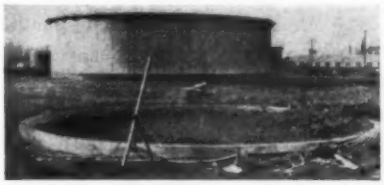
Question No. 63

Periodically the cooling tower should be shut down and thoroughly cleaned, inspected, and repaired. Generally this should be done at least:

1. Every 3 months.
2. Monthly.
3. Every 6 months.
4. Annually.
5. Every 2 years.

Question No. 64

Concrete foundation rings, such as shown below, are desirable for tanks when:



1. Tank diameter is more than 35 ft.
2. Ratio of height to diameter is more than 1.5 to 1.
3. The tank is used for fuel-oil storage.
4. The danger of fire is imminent.
5. A floating head is used.

Question No. 65

Valve maintenance is an important part of any refinery maintenance program. To do **the most effective** maintenance job on key process control valves:

1. A routine inspection procedure is instituted.
2. On failure, valve repair is handled promptly.
3. An experience record is kept, and the valve is overhauled before trouble actually occurs.
4. A bypass hand-controlled valve is installed.
5. Repairs are postponed until the valve is absolutely unusable.

Question No. 66

Proper maintenance of steam producing equipment will assure the supply of vital process steam. At high steam rates, superheater tubes may burn out, due mainly to:

1. Solid deposits from water carried over with the steam.
2. High heat-input rate.
3. Excessive pressure.
4. High flame temperature.
5. Improper use of economizers.

SAFETY

Question No. 67

There are a number of requirements for a complete, well-rounded safety program. Perhaps the most important of these is:

1. A good safety supervisor.
2. Adequate safety equipment.
3. Proper first-aid facilities.
4. Periodic safety inspections.
5. Safety consciousness on the part of all the employers.

Question No. 68

Possibly the best practical way to insure the success of a refinery safety program is to:

1. Convince top management of its importance.
2. Provide for periodic inspection by members of the safety group.
3. Remove all the hazards.
4. Provide for active participation by each and every employe.
5. Fire every negligent employe.

Question No. 69

In preparing for a refinery safety inspection, **all but one** of the following should be done:

1. Warn the personnel working in the proposed inspection area.
2. Prepare a check list of possible hazards.
3. Keep in mind previous known safety violations in the area.
4. Plan a thorough detailed inspection.
5. Give close attention to any special considerations due to the nature of the processing steps.

Question No. 70

Frequent safety meetings are essential to the success of a safety program. **All but one** of the following points should be kept in mind when planning these meetings.

1. A definite time and place should be set well in advance.
2. Arrangements should be made for plant personnel to attend, with pay.
3. Informal parliamentary procedure should be used in conducting the meetings.
4. Attendance of operating personnel from the various units is unimportant.
5. Special first-aid or safety demonstrations should be planned.

Question No. 71

In the successful safety program, literature concerning safe practices, potential hazards, accident investigations, etc., should be distributed often to the workers. To be **most effective** this literature should:

1. Draw mainly local experiences for the proper information.
2. Contain a large number of safety posters from national safety sources.
3. Contain a number of excerpts of a general nature from safety magazines, pamphlets, etc.
4. Be sent out as directives from top management to stress the importance of safety.
5. Be directed toward the general aspects of safety.

Question No. 72

One of the most important aspects of safety in the refinery is fire pro-

XUM

tection, including fire prevention and fire fighting. Perhaps the most effective fire-fighting training is accomplished by:

1. Detailed lectures and demonstrations.
2. Actual extinguishment of various classes of fires.
3. Simulated fire drills on each refinery unit, under certain specific conditions.
4. Membership in the local residential volunteer fire department.
5. Observation of actual fire fighting on a refinery unit.

Question No. 73

In refinery fire control, handling and storage of liquefied petroleum gases present some of the greatest problems. **All but one** of the following statements explain why this is true:

1. L.P.G. volatilizes very readily and thus ignites readily.
2. L.P.G. has a higher heating value per unit volume than do the heavier fractions.
3. Unconfined L.P.G. vaporizes and moves with prevailing winds as a ground-hugging "vapor cloud."
4. Ignition of a heavy vapor cloud of vaporized L.P.G. is so rapid that it simulates a true explosion.
5. On ignition L.P.G. burns with high temperatures.

Question No. 74

In modern refinery fire control the greatest of all problems is:

1. The presence of L.P.G. in large quantities.
2. Inadequacy of fire-protection systems.
3. The inadequacy of water in fighting petroleum fires.
4. Mistakes in judgment by operating personnel.
5. Lack of proper maintenance and inspection procedures.

Question No. 75

An acute refinery safety problem is the repair of equipment **in place,** when welding is required. **All but one** of the following precautions should be taken in this case:

1. All hydrocarbon lines leading to the equipment should be blinded or disconnected.
2. Pressurized safety hoods should be used where possible.
3. Adjacent units should be shut down.
4. Gas testing should be done frequently.
5. Special fire-fighting precautions should be taken.

EQUIPMENT and OPERATION

Question No. 76

In a large number of refining applications, heat transfer is accomplished by oil-to-oil contact. The heating equipment in which this transfer takes place is known as:

1. An exchanger.
2. A condenser.
3. A reboiler.
4. A cooler.
5. An aftercooler.

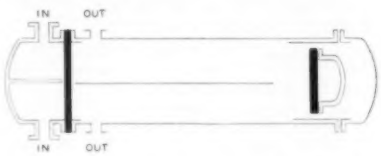
Question No. 77

Routing of fluids through a shell-and-tube heat exchanger is based on such factors as high heat-transfer rate, low pressure drop, low heat loss, etc. In the examples given below, the designated fluid should (in general) be on the tube side, in **all but one** application.

1. High-pressure fluid.
2. Corrosive stocks.
3. Vapor containing noncondensable gases.
4. Hottest fluid.
5. Fluid where pressure drop must be as low as possible.

Question No. 78

In this sketch is illustrated a well-known type of construction used in heat transfer equipment:



1. Horizontal condenser with expansion joint in shell.
2. Heat exchanger with floating head.
3. Reboiler with hairpin tube bundle.
4. Double-pipe exchanger.
5. Vertical condenser.

Question No. 79

A reciprocating pump with a single liquid cylinder, directly connected to its steam cylinder, and taking suction on both sides of the liquid cylinder is known as:

1. A triplex pump.
2. A simplex, single-acting pump.
3. A duplex, double-acting pump.
4. A simplex, double-acting pump.
5. A duplex, single-acting pump.

Question No. 80

The efficiency of a centrifugal pump is highest when operated at:

1. Nearly closed discharge.
2. High developed head.
3. The middle range of capacity.
4. Highest discharge (wide open or unimpeded capacity).
5. Very low power input.

Question No. 81

The number of fractionating trays required for fractionation of complex petroleum mixtures depends on **all but one** of the following factors:

1. Amount of stripping steam if used.
2. Charge rate to the column.
3. Reflux ratio.
4. Gap or overlap between cuts.
5. Width of cut.

Question No. 82

There are four ways to increase the capacity of an existing topping tower. One of the factors listed below will **not** increase capacity:

1. Operate at maximum allowable pressure.
2. Utilize side reflux.
3. Produce a minimum overhead product.
4. Draw off distillate and gas oil very low in the tower.
5. Decrease the feed temperature.

Question No. 83

It is possible to use several types of fractionating towers to make a desired separation, but the type used almost exclusively in the petroleum industry incorporates:

1. Bubble-cap trays.
2. Baffle plates.
3. Slotted trays.
4. An empty tower.
5. A packed column.

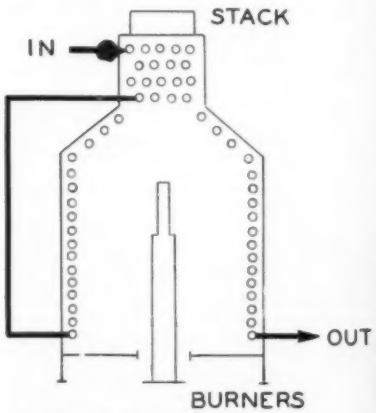
Question No. 84

Side reflux is used in a number of fractionation towers operating on complex mixtures. **All but one** of these statements concerning side reflux are true:

1. It reduces the required tower diameter.
2. It is better for heat exchange than top reflux.
3. Hot liquid is drawn from the tower, cooled, and pumped back into the tower one or two trays higher.
4. The tower top vapor load is reduced.
5. Side reflux is obtained by condensing part of the column overhead and pumping it into the tower down a few plates from the top.

Question No. 85

There are a number of arrangements possible for pipe-still firing and tube location. Pictured here is a:



1. A-frame still.
2. Down convection still.
3. Double upfired still.
4. Single upfired still.
5. Center convection still.

Question No. 86

The net heating value of the fuel is needed to make a heat balance on a fired petroleum heater. The net heating value per unit quantity of fuel is defined as:

1. Heat produced at constant temperature, water vapor being condensed.
2. Heat produced at constant temperature, water vapor uncondensed.
3. The heat absorbed by the heated oil stream.
4. Heat absorbed in the radiant section of the heater.
5. Heat absorbed in the convection section of the heater.

Question No. 87

Modern refining methods place emphasis on the efficient utilization of heat. In this connection the economic approach temperature in an exchanger is characterized by:

1. A large approach temperature, due to low equipment outlay.
2. A very close approach temperature, due to high heat recovery.
3. A moderate approach temperature, obtained by balancing heat savings with equipment costs.
4. Substantially 100 per cent utilization of waste heat.
5. Very small utilization of waste heat.

Question No. 88

Conditions of flow within heat

transfer equipment have a lot to do with the value of Δt (temperature difference) to be used in computing the amount of heat transfer. Counter-current flow is defined by:

1. Both the hot and cold fluids travel through the apparatus in the same direction.
2. Hot and cold fluids travel in opposite directions.
3. Heating fluid remains at constant temperature.
4. Cooling fluid remains at constant temperature.
5. As a limit, the cold fluid approaches the outlet temperature of the hot fluid.

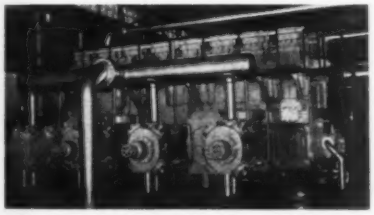
Question No. 89

Compressors are used in refinery work for compression of vapor fractions. **All but one** of these statements are true concerning centrifugal compressors.

1. They are very dependable.
2. Upper limit on discharge is about 200 psig.
3. They are easily repaired.
4. They are economical to operate.
5. Very few repairs are required.

Question No. 90

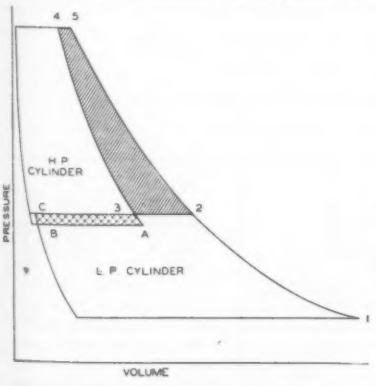
Pictured here is a machine used in handling light hydrocarbon fractions. It is a:



1. Centrifugal compressor.
2. Centrifugal pump.
3. Positive displacement pump.
4. Reciprocating compressor.
5. Cascade tray fractionating tower.

Question No. 91

Power savings result when two or more stages are used in gas compression. This is an indicator diagram for



a two-stage compressor. The amount of work saved (over one-stage compression) is represented by area:

1. B-A-3-C.
2. B-A-3-C plus 2-3-4-5.
3. 2-3-4-5.
4. Labeled "L. P. cylinder."
5. Labeled "H. P. cylinder."

Question No. 92

The time for cracking plant shutdowns is usually determined from previous experience under the same cracking conditions, on the same or similar feedstocks. However, if tube-wall temperature could be measured accurately in the region of greatest coke formation, shutdown time could be determined as operation proceeded, since increasing coke thickness causes:

1. A decrease in temperature difference (Δt) between the tube wall and the oil.
2. Considerable cycling of wall temperature.
3. A decrease in tube-wall temperature.
4. An increase in Δt between the tube wall and oil.
5. Increase in heat transfer rate.

Question No. 93

In determining the steam requirements of turbines, it must be remembered that:

1. Little if any steam condenses.
2. Approximately 90 per cent of the heat in the steam can be utilized in the turbine.
3. The steam expands isothermally (constant temp.).
4. Turbine efficiency (actual per cent utilization of available heat energy) runs about 95 per cent for single stage turbines.
5. There are 778 B.t.u. in 1 hp.

STORAGE

Question No. 94

In the storage of crude oil in atmospheric tanks, vapor loss is dependent on **all but one** of the following factors:

1. Vapor pressure of the oil.
2. Oil temperature.
3. Variation in oil temperature.
4. Tank insulation.
5. Kind of metal used in tank construction.

Question No. 95

Total yearly costs of crude oil storage for various types of atmospheric tanks, when the tanks are filled frequently are greatest for the:

1. Water-filled storage tanks.
2. Pontoon floating-roof tanks.
3. Balloon or piston-type-roof tanks.
4. Plain or fixed-roof tanks.
5. Flexible or breather-roof tanks.

Question No. 96

In some refineries the crude oil is stabilized before storage. The purpose of the stabilization step is to:

1. Raise the A.P.I. gravity of the crude.
2. Reduce its temperature before storage.
3. Substantially reduce evaporation loss during storage.
4. Increase the volume of the crude.
5. Increase the vapor pressure of the crude.

Question No. 97

For storage of volatile liquids, spheres or flattened spheres have proved to be most economical. This is true because:

1. Thinner plate may be used in construction.
2. Insulation costs are cheaper.
3. Construction costs are cheaper.
4. Tanks of this shape are more easily supported.
5. Storage temperatures are lower.

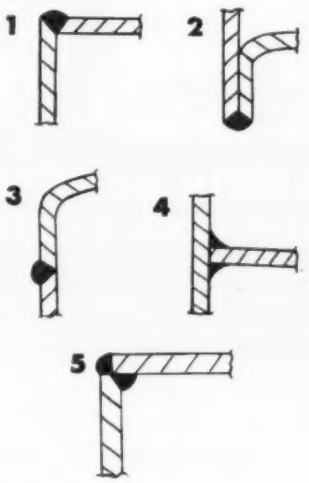
Question No. 98

Storage tanks used for very heavy-oil stocks, such as fuel oils or asphalt, should be equipped with coils for steam heat. In specifying heating surface, it is well to remember that:

1. Heat input rate to cold oil is much lower than to hot oil.
2. Heat input rate to hot oil is much higher than to cold oil.
3. Heat input rate remains approximately constant throughout the heating period.
4. Time of heating has no bearing on the problem.
5. Viscosity of the oil is not important.

Question No. 99

Design and construction of tank ends are important factors in determining the rating of pressure tanks. **Only one** of the following joints is recommended:



1.
2.
3.
4.
5.

Question No. 100

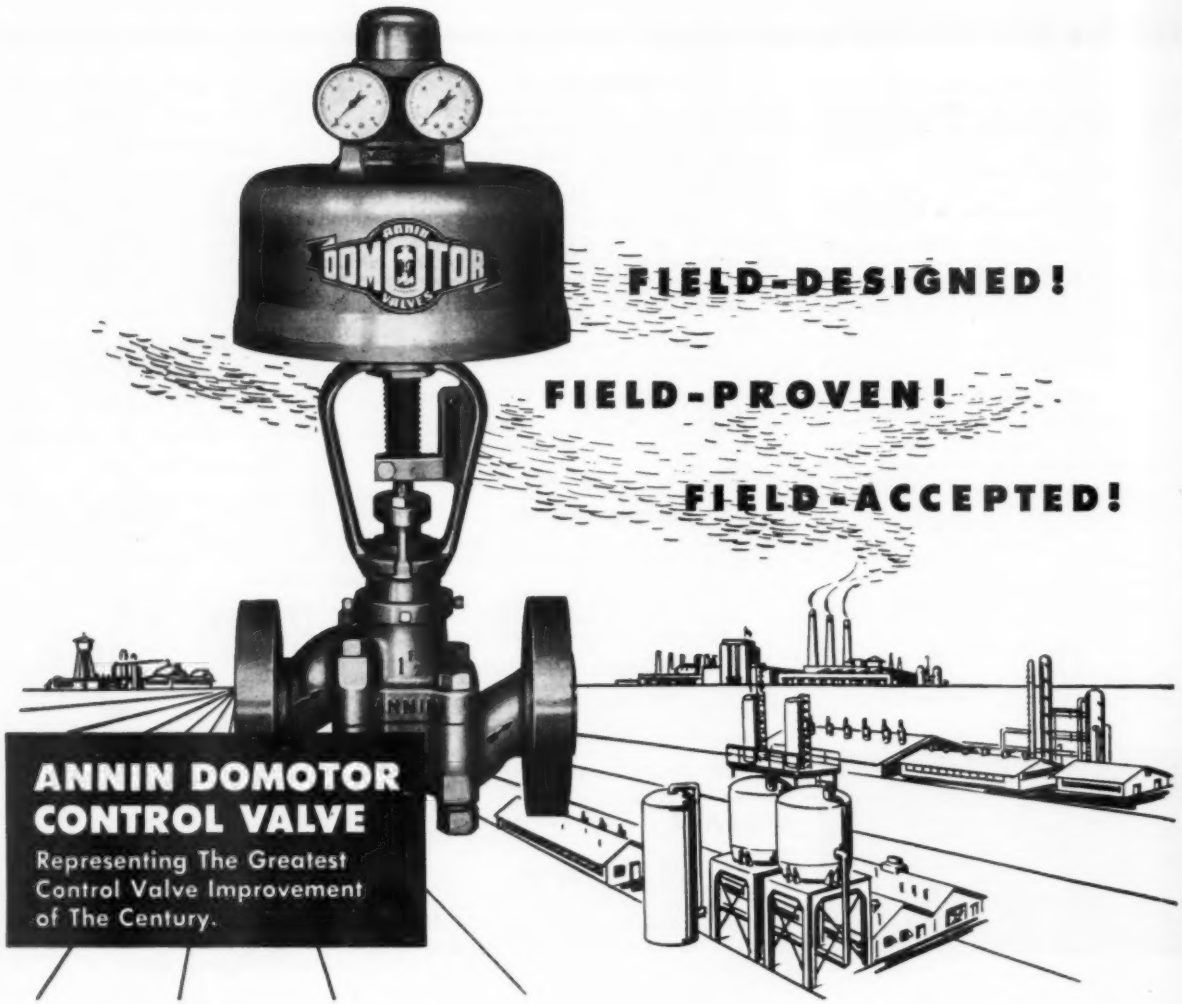
For purposes of inventory and sales, strapping of refinery storage tanks is quite important. **All but one** of the following statements concerning strapping are true:

1. Strapping is the determination of amount of material in the tank vs. height of filling.
2. Strapping marketing tanks should be done by professional strappers.
3. Strapping tanks used solely for refinery movements can generally be done with sufficient accuracy by refinery personnel.
4. Strapping of all tanks by rough approximation is permissible.
5. Strapping spheroids should be done by professional strappers.

Question No. 101

Several points should be kept in mind in designing foundations for storage tanks. One of the most important is:

1. Proper water drainage from the base of the tank should be provided.
2. High soil loads occur, due to the weight of the tank and its contents.



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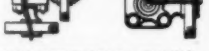

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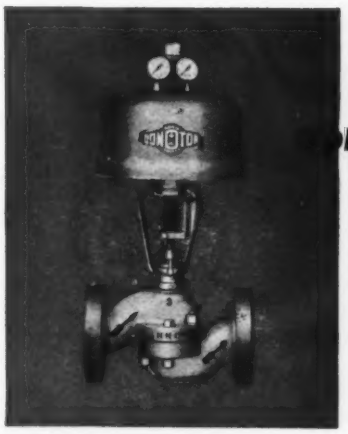

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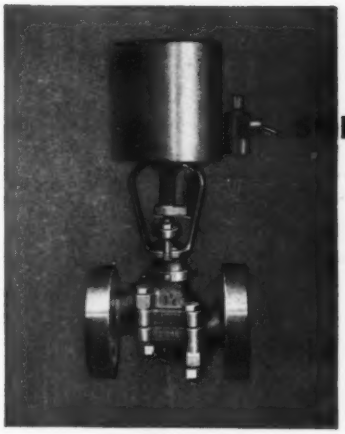

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3. It is usually necessary to provide concrete piles to support the tank.
4. Tank bottoms do not corrode on the outside.
5. A solid concrete slab is usually laid to support the tank.

Question No. 102

The umbrella-roof type of atmospheric storage tank is widely used. It is used when:

1. Large-diameter tanks are required.
2. Adequate internal supports can be provided.
3. Tank diameter is 24 ft. or less.
4. Conditions are conducive to excessive vapor loss.
5. A floating-head tank is required.

Question No. 103

Often, too little attention is paid to the venting requirements of atmospheric storage tanks. For cone-roof type storage tanks, **all but one** of the following statements are true:

1. As oil is pumped in, an equal volume of vapor is forced out the tank vent.
2. Failures of tank roofs have occurred, due to inadequacy of the vents.
3. Vapor is evolved during a temperature rise.
4. Air is drawn into the tank during a decrease of temperature.
5. Change in temperature has no effect on breathing.

CORROSION

Question No. 104

Corrosion is costing American industry **at least as much** as the current annual cost of the European Recovery Program. This cost is approximately:

1. $1,000,000,000.
2. $100,000,000.
3. $500,000,000.
4. $5,500,000,000.
5. $50,000,000,000.

Question No. 105

Internal corrosion of pipes is a big problem with the refiner of petroleum. To date the most effective practical way of combating this corrosion is:

1. Lowering the transfer temperature.
2. Increasing the pressure.
3. Water elimination by gravity settling.
4. Increasing stream velocity.
5. Use of internal linings.

Question No. 106

Chemical deterioration of cooling-tower lumber is a serious problem in some areas. The term, "delignification" is used to describe:

1. Corrosion of steel tower supports.
2. Removal of alkali or bisulfite-soluble matter.
3. Removal of oils and resins.
4. Serious attack by algae.
5. Removal of cellulose.

Question No. 107

In operation of cooling towers to prevent lumber deterioration **all but one** of the following statements are true:

1. High chlorine concentrations have no effect on deterioration.
2. California redwood is more resistant to deterioration than cypress or yellow pine.
3. High pH values (alkaline conditions) lead to deterioration.
4. Deterioration occurs at low pH values (acid conditions).
5. Wooden towers should not be coated where water is in contact with the wood.

Question No. 108

Corrosion inhibition with chromates has been practiced for some time in the refining industry. From a chemical standpoint the corrosion-inhibiting value of a soluble chromium compound is determined by:

1. The total amount of chromium in solution.
2. The presence of chromium compounds which are green in color.
3. Velocity of circulation of the water containing the compound.
4. The amount of hexavalent chromium (yellow or red in color) present.
5. The other elements in chemical combination with chromium.

Question No. 109

Chromate paints have been found to possess properties for corrosion inhibition for equipment fabricated from iron, steel, aluminum, etc. Practically all yellow paints are made from:

1. Chromic acid.
2. Sodium chromate.
3. Lead chromate.
4. Potassium dichromate.
5. Aluminum chromate.

Question No. 110

The use of chromate in water circulating through cooling towers has several advantages. All but one of the following advantages are realized:

1. Protection against corrosion.
2. Reduction or elimination of organic slimes and deposits.
3. Reduction of algae formation.
4. Increase in allowable salt concentration.
5. Reduction of evaporation losses.

Question No. 111

Proper control of pH is important when using chromate corrosion protection. One of the following statements concerning proper pH values **is not true:**

1. Under most conditions, the correct pH is from 7.5 to 9.5 (slightly alkaline).
2. Chromate is an effective inhibitor of steel at pH of 5.5 (slightly acidic).
3. Waters having a pH below 7.0 (acidic) are corrosive without chromate addition.
4. Less chromate is required if the solution is acidic (pH below 7.0).
5. More chromate is required if the solution is acidic.

Question No. 112

Severe corrosion difficulties may be experienced in refining sour crudes. These difficulties are due to the presence of hydrogen sulfide at some phase in the refining operation. This gas:

1. Is highly corrosive but otherwise is perfectly safe.
2. May be detected in all concentrations by its characteristic odor.
3. Has a pale yellow color.
4. Will not form an explosive mixture with air.
5. Is extremely poisonous.

Question No. 113

Corrosion of refinery equipment due to hydrogen sulfide is a serious problem when refining sour crudes. It is particularly serious when:

1. Asphalt base crude is refined.
2. Processing temperatures reach 650°-700° F., or higher.
3. High-gravity crude is being handled.
4. Transfer lines are coated with cement or plastic.
5. Processing under pressure.

Question No. 114

Storage of sour crude in tanks presents corrosion problems, particularly when:

1. Hydrogen sulfide breaks down, on being mixed with air.
2. Welded construction is used.
3. The tank is tightly sealed from the atmosphere.
4. The liquid level in the tank fluctuates considerably.
5. The weather is excessively cold.

Question No. 115

Corrosion by hydrogen sulfide from sour crudes is especially serious in cracking units. This problem may be handled by:

1. Lowering the cracking temperature.
2. Increasing the throughput.
3. Increasing the pressure.
4. Using alloy steels in the hot portions of the units.
5. Reducing the soaking time.

Question No. 116

Crude oils containing salt are corrosive, due to the fact that during distillation:

1. The salts are volatile and will vaporize, thus contacting all parts of the equipment.
2. The salts remain in solution.
3. The salts break down to form hydrogen chloride, which is very corrosive when moist.
4. It is difficult to vaporize the crude, and higher temperatures must be used.
5. The salts become insoluble and deposit out.

Question No. 117

One of the most efficient ways to remove salt from petroleum is through the use of electrical desalting. **All but one** of these statements are true concerning this process:

1. Additional water of low salt content is added to the crude.
2. Total water content is precipitated in an electrical precipitator.
3. 90 to 95 per cent of the salt is removed by this method.
4. Some hydrogen sulfide and some elementary sulfur are removed by this process.
5. Water and salt vaporize and are removed from the crude.

CHEMISTRY

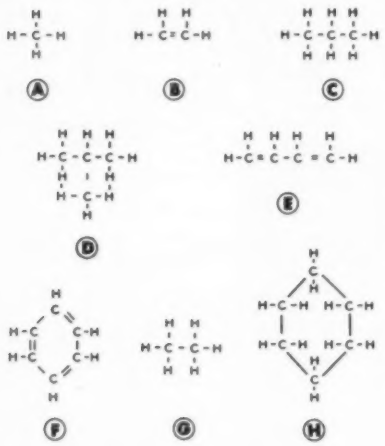
Question No. 118

Crude oil is a complex mixture of many substances. The majority of the chemical compounds present may be classified as:

1. Paraffin hydrocarbons.
2. Olefins.
3. Aromatics.
4. Diolefins.
5. Acetylenes.

Questions No. 119-122

This group of chemical formulas



represents chemical compounds associated with petroleum processing. Some of these formulas are identified in the following four statements. Write on the answer sheet (opposite the number of each statement) the number which correctly describes each of the statements below:

Question No. 119

This compound is benzene, an aromatic compound which is a valuable byproduct of petroleum processing.

Question No. 120

A compound used in making synthetic rubber is butadiene, represented by this formula.

Question No. 121

A necessity in alkylation, isobutane is designated by this formula.

Question No. 122

This compound, ethylene, is a raw material used in the petrochemical industry.

Question No. 123

The antiknock quality of motor gasoline is usually designated by its "octane" number. The **upper** limit of the reference scale is 100 octane, corresponding to the chemical compound:

1. Normal octane.
2. Isohexane.
3. Normal pentane.
4. Isooctane.
5. Normal heptane.

Question No. 124

In the usual alkylation process, these two compounds are usually combined chemically:

1. Propane and n-butane.
2. Ethylene and propylene.
3. Propylene and butylene.
4. Ethylene and isopentane.
5. Isobutane and butylenes.

Question No. 125

In the butane isomerization process, the following chemical transformation occurs:

1. n-Butane to n-pentane.
2. Isobutane to n-butane.
3. n-Butane to isobutane.
4. Isobutane to isopentane.
5. Butane to propane.

Question No. 126

In the ketone refining of lubricating oil the chemical compound used as solvent is:

1. Dimethyl ketone.
2. Methyl ethyl ketone.
3. n-Heptane.
4. Propane.
5. Butane.

CONSTRUCTION MATERIALS

Question No. 127

Some refineries operating on sour crudes have experienced severe tank corrosion. One of the following materials shows promise for tank roof construction:

1. Low-carbon steel.
2. Aluminum.
3. Brass.
4. Iron sulfide.
5. Iron oxide.

Question No. 128

Corrosion occurs in topping towers and auxiliary equipment when running sour crude. **All but one** of the following methods may be used to aid in suppressing this corrosion:

1. Gunite may be used to cover the walls and bottom of the tower.
2. Meehanite (high-carbon, high-silicon cast iron) may be used to construct trays and caps.
3. Ammonia may be introduced into the oil vapor line leaving the tower (to protect heat exchangers).
4. Aluminum bubble caps may be used.
5. Moist HCl may be introduced with the crude charge.

Question No. 129

Gunite is sometimes used for coating and lining refinery equipment to make it corrosion resistant. Gunite consists of:

1. A thin metal liner.
2. A hard rubber lining.
3. A mixture of cement and crushed brick.
4. A transparent plastic.
5. High-melting glass.

Question No. 130

Refining of sour crude causes a number of corrosion problems throughout the refinery. **All but one** of the following statements are true concerning corrosion incurred in processing sour crude:

1. Condensers may require Monel metal shells or liners.
2. Stainless-steel exchanger tubes are recommended for cracked residuum.
3. Still tubes and transfer lines should be of stainless steel if operated at 650° F. or above.
4. Monel still tubes are required at temperatures of 300°-400° F.
5. Ganister linings may be used to reduce corrosion in settler vessels when desalting sour crude.

Question No. 131

The use of a small amount of titanium in stainless steel is indicated for a number of applications. The effect of adding titanium is:

1. Increased corrosion resistance at high temperatures.
2. Reduced creep strength.
3. Increased tendency to become brittle.
4. Oxidation resistance is decreased.
5. Impact strength is reduced.

Question No. 132

In selecting alloy steel for specific application, the effects of the various constituents present should be known. All but one of the following statements are true:

1. Chromium-nickel steels are resistant to many forms of corrosion.
2. Molybdenum in steel is useful in promoting high-temperature strength.
3. Phosphorus in appreciable quantities is objectionable.
4. Silicon in steel tends to increase resistance to oxidation at high temperatures.
5. 1 to 2 per cent sulfur in steel adds to tensile strength.

Question No. 133

Metals are selected for specific application to reduce refinery corrosion. One of the following statements concerning application is **incorrect:**

1. Chromium resists sulfur corrosion above 500° F.
2. Hastelloy B is used in isomerization equipment to resist HCl.
3. Monel is widely used in HF alkylation.
4. 18-8 stainless steel is resistant to hydrogen attack.
5. Low-carbon steel is satisfactory at relatively high pressures and temperatures of 1,500° to 2,000° F.

Question No. 134

"Clad" steels are being used in some refinery installations. **All but one** of the following statements concerning clad steels are **true:**

1. Temperatures of operation may be as high as 1,500° F., or higher.
2. Clad steels are produced by hot rolling.
3. Greater economy is realized when using clad steels for some applications.
4. Thickness of corrosion-resistant liner is normally about 75 per cent of the total thickness of the clad steel.
5. Clad steels with stainless liners have higher heat conductivity than solid stainless steels.

Question No. 135

Metal for heat-exchanger tubes should be selected carefully, depending on the fluids processed. For water-cooled condensers the tubes are made almost exclusively from:

1. Steel.
2. Nickel.
3. Admiralty metal or copper-base metal.
4. Stainless steel.
5. Inconel.

UTILITIES

Question No. 136

In the operation of most steam boiler systems, a schedule for regular blowdowns is in operation. The purpose of the blowdown is to:

1. Control the steam temperature.
2. Maintain proper water level.
3. Lower the boiler pressure.
4. Decrease the required makeup water.
5. Keep soluble salt concentration at a safe value.

Question No. 137

Water treatment is often used to condition properly the makeup water for a steam boiler system. **All but one** of these statements, concerning impurities in water, are true:

1. Organic matter leads to corrosion and foaming in boilers.

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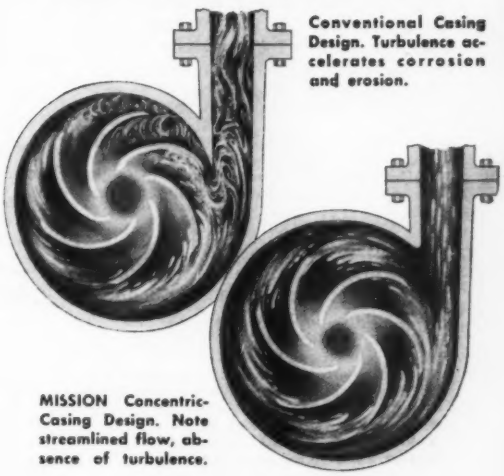
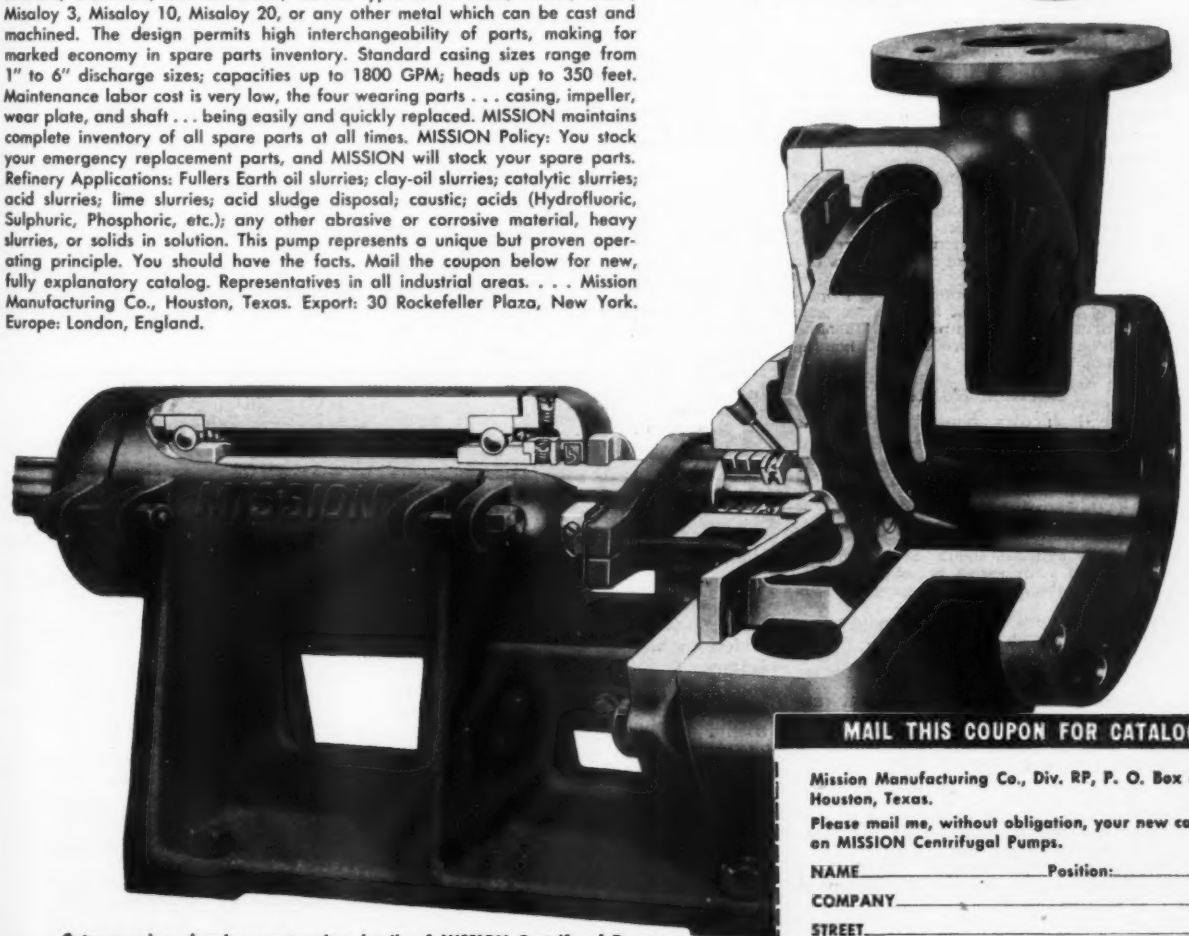
BECAUSE . . . concentric casing eliminates vibration throughout the entire range of operation, even if the discharge is completely blocked.

The wear factors are further reduced, in the MISSION Pump, by use of the correct corrosion and erosion resistant alloys for the parts coming in contact with the fluids pumped. These parts are available in cast iron, carbon steel, bronzes, aluminum, stainless steels, various types of Ni-Resist, Monel, nickel, Misaloy 3, Misaloy 10, Misaloy 20, or any other metal which can be cast and machined. The design permits high interchangeability of parts, making for marked economy in spare parts inventory. Standard casing sizes range from 1" to 6" discharge sizes; capacities up to 1800 GPM; heads up to 350 feet. Maintenance labor cost is very low, the four wearing parts . . . casing, impeller, wear plate, and shaft . . . being easily and quickly replaced. MISSION maintains complete inventory of all spare parts at all times. MISSION Policy: You stock your emergency replacement parts, and MISSION will stock your spare parts. Refinery Applications: Fullers Earth oil slurries; clay-oil slurries; catalytic slurries; acid slurries; lime slurries; acid sludge disposal; caustic; acids (Hydrofluoric, Sulphuric, Phosphoric, etc.); any other abrasive or corrosive material, heavy slurries, or solids in solution. This pump represents a unique but proven operating principle. You should have the facts. Mail the coupon below for new, fully explanatory catalog. Representatives in all industrial areas. . . . Mission Manufacturing Co., Houston, Texas. Export: 30 Rockefeller Plaza, New York. Europe: London, England.



Conventional Casing Design. Turbulence accelerates corrosion and erosion.

MISSION Concentric-Casing Design. Note streamlined flow, absence of turbulence.



Cutaway view showing construction details of MISSION Centrifugal Pump.

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2. Grease and oil lead to corrosion and incrustation in the boiler system.
3. Presence of magnesium chloride and sulfate in the water may be ignored.
4. Sulfate of lime (or calcium sulfate) produces a tightly adhering scale on heated surfaces.
5. Bicarbonates of lime and magnesia (calcium and magnesium bicarbonates) cause boiler scale and suspended matter.

Question No. 138

Scale or deposits may be formed in heat exchangers and in boilers, due to impurities in the cooling water and the boiler feed water. The effect of this scale is to:

1. Increase heat transfer.
2. Reduce the required amount of cooling water.
3. Protect the tubes from "burning out."
4. Greatly reduce heat transfer.
5. Decrease the temperature difference from heating to heated fluid.

Question No. 139

When steam is used to heat petroleum fluids, there is always danger of steam contamination by oil due to leaks. The presence of oil in the steam in the exchanger causes:

1. Increased heat transfer.
2. Coating of the exchanger surface with oil and consequent reduced heat transfer.
3. Plugging of the steam trap.
4. Reduction in steam pressure.
5. Increased steam consumption.

Question No. 140

A number of improvements in power generation facilities have been made in many refineries in recent years. **All but one** of these statements are true concerning these improvements:

1. Boilers are now being operated above the critical temperature of water.
2. Higher steam pressures, plus superheat, are being used.
3. Extraction steam from high pressure turbines may be used for reboilers and prime movers.
4. Boilers in some installations are operating at pressures of 900 to 1,200 psig.
5. Exhaust from high-pressure turbines may be used for process and heating steam.

Question No. 141

Several factors contribute to the problem of lubricating air compressor cylinders. **One** of these statements is **not** correct:

1. Operating pressure of the cylinder is important.
2. Jacket-water temperatures of the compressor cylinder should be considered.
3. Ratio of compression is not important.
4. The number of compression stages is important.
5. Contamination of the gas should be as low as possible.

Question No. 142

Fresh-air input to the plant air compressors always contain some water. In considering this water it should be remembered that:

1. Water concentration in the air is unimportant.
2. Presence of liquid water in the air fed to the second stage of an air compressor is unimportant.
3. Coolers between stages should have separators for removal of condensed moisture.
4. Water cannot condense out in high-pressure air.
5. Interstage separators are not required.

Question No. 143

A number of refineries are now producing all necessary electricity for refining use. This step is due mainly to the fact that:

1. Power is usually not available in sufficient quantity.
2. Considerable savings result thereby.
3. Frequency variation in electric power purchased from commercial sources is too great.
4. Voltage regulation of purchased power is not good.
5. Refinery power factors are rather low.

Question No. 144

Generators for refinery electrical power are usually driven by:

1. Low-speed reciprocating steam engines.
2. Gasoline engines.
3. Diesel engines.
4. Air-motivated machines.
5. High-speed steam turbines.

GEOGRAPHICAL

Question No. 145

Currently, 72 United States refineries produce finished lube oils. Capacity rating on all of these plants is 177,662 bbl. of oil daily. The area in which the largest number of lube-oil plants are located produces only 11.5 per cent of the nation's total finished oils. This area is known as:

1. Mid-Continent.
2. Eastern.
3. Pacific Coast.
4. Pennsylvania.
5. Gulf Coast.

Question No. 146

Crude-oil input capacity of the nine largest complete refineries operating in the United States is nearly 2,000,000 bbl. daily total. Combined crude oil input capacity of three large refineries operating outside of the United States is more than 1,000,000 bbl. per day. The largest complete refinery in this group of 12 operating plants is located in:

1. Aruba.
2. New Jersey.
3. Louisiana.
4. Iran.
5. Texas.

Question No. 147

Today's industrial infant is petrochemical processing. Equipment investments in plants for producing raw, semifinished, and finished petroleum-derived chemicals are estimated to be hundreds of millions of dollars. On a basis of productive capacity, 85 per cent of the nation's petrochemical plants are centered within a 200-mile radius of:

1. Brownsville, Tex.
2. Houston.
3. Charleston, W. Va.
4. New Orleans.
5. St. Louis.

Question No. 148

A number of the plants producing components for synthetic-rubber manufacture were placed in standby service after the emergency of World War II had been relieved. Recent developments in United States defense plans call for reactivation of some of the standby installations. The first of these plants to be reactivated is located near:

1. Baton Rouge.
2. Houston.
3. Lake Charles, La.
4. Borger, Tex.
5. Port Neches, Tex.

CURRENT NEWS

Question No. 149

Gulf Oil Corp. has announced plans for building the world's largest fluid catalytic cracking unit. This unit will have a capacity, in barrels per day, of:

1. 10,000.
2. 40,000.
3. 60,000.
4. 90,000.
5. 175,000.

Question No. 150

Which of the following petroleum materials, furnishing the bulk of the "building blocks" or starting materials used in petrochemical manufacture, reached an estimated consumption of over 3.3 billion pounds in 1950?

1. Paraffins.
2. High-vacuum residuals.
3. Special naphthas.
4. Olefins.
5. Virgin naphthas.

Question No. 151

Research is being conducted with a new spectrometer featuring unusually high resolving power. The new instrument is intended to supplement existing spectrometers, particularly to distinguish certain hydrocarbon derivatives from the hydrocarbons themselves. A special feature of this spectrometer is that it involves the use of:

1. Mirrors and prism.
2. Microwaves such as those employed in radar.
3. Ultraviolet rays.
4. Reflected light.
5. Coated lenses.

Question No. 152

The first commercial production of high-purity benzene from petroleum was announced during 1950 as coming from the:

1. Standard Oil Co. (Ind.) Whiting refinery.
2. Shell Oil Co. Houston refinery.
3. Pan-American Refining Co. Texas City plant.
4. Leonard Refineries plant at Alma, Mich.
5. Continental Oil Co. Ponca City refinery.

Question No. 153

In the new experimental internal combustion engine, known as the Texaco T.P.C. engine, performance without knock is obtained under widely varying operating conditions by:

1. Use of superior, high-octane gasoline.
2. Changing the compression ratio.

3. Delaying detonation.
4. Creating air swirl in the cylinder.
5. Use of L.P.G. as fuel.

Question No. 154

Current construction in Canada will boost Canadian refining capacity from 65,500 bbl. per day to a total daily capacity of:

1. 70,500 bbl.
2. 252,000 bbl.
3. 393,000 bbl.
4. 1,451,000 bbl.
5. 860,000 bbl.

Question No. 155

In Sun Oil Co.'s new catalytic cracking unit, level of hot catalyst is measured continuously by:

1. Stainless-steel probes.
2. Radium, gamma rays, and geiger counters.
3. Displacement-float liquid-level gage.
4. Differential pressure meter.
5. An emission spectrometer.

Question No. 156

How many oil companies are engaged in production of starting materials used in petrochemistry or in the synthesis of intermediate and finished products from them?

1. More than 25.
2. 5.
3. 11.
4. 19.
5. 53.

Question No. 157

The number of workers of all types employed in the refining branch of the oil industry is reported at approximately:

1. 38,000.
2. 50,000.
3. 150,000.
4. 700,000.
5. 1,300,000.

Question No. 158

A news item recently stated that capital expenditures in the refining branch of the oil industry during 1949 totaled:

1. $30,000,000.
2. $85,000,000.
3. $508,000,000.
4. $916,000,000.
5. $1,224,000,000.

Question No. 159

National Safety Council figures for 1949 showed that the manufacturing department of Socony-Vacuum Oil Co., Inc., had the best safety record among major refiners. The Socony-Vacuum record showed the following number of disabling injuries for each 1,000,000 man-hours worked in 1949:

1. 0.
2. 0.1.
3. 1.85.
4. 193.
5. 1,000.

Question No. 160

At Louisiana State University work is being done on certain aspects of refinery waste disposal. Evaluation of the toxicity of refinery effluents is being accomplished through exposure, to varying concentrations of chemicals found in refinery wastes, of:

1. Bluegill and other fish.
2. Small crustaceans called Daphnia Magnus.
3. Bacillus coli.
4. A specially cultivated strain of amoeba.
5. Anaerobic bacteria.

Question No. 161

With completion of recent large-scale refinery construction the daily refining capacity of the South American mainland plus that of the islands of Aruba, Curacao, and Trinidad now totals in the neighborhood of:

1. 89,000 bbl.
2. 250,000 bbl.
3. 365,000 bbl.
4. 800,000 bbl.
5. 1,300,000 bbl.

Question No. 162

At the 1950 annual meeting of the National Petroleum Association in Atlantic City, aviation jet fuels were discussed. T. L. Apjohn of Socony-Vacuum Oil Co., Inc., stated that jet fuels can be properly prepared by blending:

1. 115/145 grade aviation gasoline and kerosine.
2. Stabilized gasoline, kerosine and light-fuel-oil stock.
3. Gasoline and alcohol in a 70:30 ratio.
4. Different wide-boiling distillates.
5. Straightrun naphthas.

Here Are Work Sheets for Your Answers

INSTRUCTIONS: Clip out one of the work sheets below. If you are doing this with one or two friends, tear out one complete work sheet for each. Then turn back to the start of the quiz, and commence. Mark your answers on the spaces in the work sheets. Then turn to page 300 to check your efforts against the correct answers.

WORK SHEET NO. 1

Ques. 1.....	Ques. 21.....	Ques. 41.....	Ques. 62.....	Ques. 83.....	Ques. 104.....
Ques. 2.....	Ques. 22.....	Ques. 42.....	Ques. 63.....	Ques. 84.....	Ques. 105.....
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Ques. 13.....	Ques. 33.....	Ques. 53.....	Ques. 74.....	Ques. 95.....	Ques. 116.....
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		Ques. 61.....	Ques. 82.....	Ques. 103.....	Ques. 124.....

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WORK SHEET NO. 2

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WORK SHEET NO. 3

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Ques. 123	Ques. 133	Ques. 143	Ques. 153
Ques. 124	Ques. 134	Ques. 144	Ques. 154
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Ques. 129	Ques. 139	Ques. 149	Ques. 159
Ques. 130	Ques. 140	Ques. 150	Ques. 160
Ques. 131	Ques. 141	Ques. 151	Ques. 161
Ques. 132	Ques. 142	Ques. 152	Ques. 162

. . . And Here Are the Answers

These are the correct answers for the Refresher-Quiz. Check your quiz work sheets against these.

Question Number	Correct Answer	Reference in The Oil and Gas Journal
EXAMPLE		
0	1	Various
INTRODUCTORY		
1	4	Various
2	1	Various
3	5	Various
4	4	Various
5	3	Various
6	2	Various
7	1	Various
8	3	Various
9	1	Various
10	5	Various
11	4	Various
12	1	Various
PROCESSING		
13	2	Mar. 29, 1951, p. —
14	1	Mar. 29, 1951, p. —
15	5	Mar. 29, 1951, p. —
16	2	Mar. 23, 1950, p. 241
17	3	Mar. 16, 1946, p. 103
18	*4	Mar. 23, 1950, p. 181 (*Note: No catalyst used)
19	3	Mar. 23, 1950, p. 261
20	4	Mar. 23, 1950, p. 198
21	3	Mar. 23, 1950, pp. 171-176
22	1	Mar. 23, 1950, p. 252
23	2	Mar. 23, 1950, pp. 190-197
24	1	Mar. 23, 1950, pp. 202-208
25	3	Nov. 2, 1950, p. 74
26	5	Nov. 2, 1950, pp. 74-75
27	3	Nov. 2, 1950, pp. 74-75
28	5	Nov. 2, 1950, pp. 74-75
29	5	Mar. 23, 1946, p. 81
30	3	Sept. 28, 1946, p. 93
31	4	Mar. 24, 1949, p. 155
32	2	Oct. 19, 1950, p. 63
33	5	Oct. 26, 1950, p. 76
34	1	Dec. 28, 1950, p. 78
35	2	Nov. 16, 1950, p. 283
36	1	Oct. 12, 1950, p. 84
37	3	Oct. 12, 1950, p. 84
38	5	Oct. 12, 1950, p. 88
39	4	June 22, 1950, p. 166
INSTRUMENTATION		
40	3	Oct. 26, 1950, p. 77
41	D	May 25, 1950, p. 161
42	F	Mar. 23, 1950, p. 351
43	C	Mar. 23, 1950, p. 351
44	G	May 25, 1950, p. 161
45	2	Oct. 12, 1950, p. 125
46	3	Mar. 9, 1950, p. 103
47	1	Aug. 17, 1950, p. 141
48	3	Sept. 14, 1950, p. 133
49	4	May 11, 1950, p. 103
50	4	July 13, 1950, p. 105
51	5	Sept. 28, 1950, p. 103
52	2	Oct. 5, 1950, p. 261
53	5	Sept. 21, 1950, p. 373
54	1	Mar. 23, 1950, p. 272
MAINTENANCE		
55	4	May 18, 1950, pp. 145-156
56	1	May 18, 1950, pp. 145-156
57	2	May 18, 1950, pp. 145-156
58	4	May 18, 1950, pp. 145-156
59	2	May 18, 1950, pp. 145-156
60	5	Apr. 20, 1946, p. 150
61	2	Apr. 20, 1946, p. 150
62	3	Apr. 1, 1948, p. 194
63	4	Apr. 1, 1948, p. 193
64	1	Apr. 1, 1948, p. 197
65	3	Apr. 1, 1948, p. 185
66	1	Apr. 1, 1948, p. 201
SAFETY		
67	5	July 27, 1950, pp. 318-322
68	4	July 27, 1950, pp. 318-322
69	1	July 27, 1950, pp. 318-322
70	4	July 27, 1950, pp. 318-322
71	1	Mar. 23, 1950, pp. 246-250
72	3	Mar. 23, 1950, pp. 246-250
73	2	Mar. 2, 1950, p. 59
74	4	Mar. 2, 1950, p. 79
75	3	July 27, 1950, p. 334
EQUIPMENT AND OPERATION		
76	1	Feb. 9, 1946, p. 111
77	5	Mar. 2, 1946, p. 91
78	2	Feb. 9, 1946, p. 111
79	4	May 17, 1947, p. 113
80	3	June 21, 1947, p. 115
81	2	Oct. 6, 1945, p. 117
82	5	Nov. 17, 1945, p. 293
83	1	Aug. 11, 1945, p. 125
84	5	Aug. 18, 1945, p. 155
85	3	Aug. 24, 1946, p. 128
86	2	Oct. 5, 1946, p. 111
87	3	Oct. 14, 1944, p. 110
88	2	Oct. 14, 1944, p. 110
89	2	June 29, 1950, p. 66
90	4	May 18, 1950, p. 124
91	3	Feb. 23, 1950, p. 183
92	4	Apr. 19, 1947, p. 130
93	1	May 26, 1945, p. 147
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94	5	Jan. 20, 1945, p. 87
95	4	Jan. 20, 1945, p. 87
96	3	Aug. 5, 1944, p. 75
97	1	Sept. 2, 1944, p. 61
98	3	Oct. 7, 1944, p. 103
99	3	Sept. 9, 1944, p. 95
100	4	Sept. 23, 1944, p. 293
101	1	Oct. 21, 1944, p. 137
102	3	Apr. 1, 1948, p. 196
103	5	Apr. 1, 1948, p. 216
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104	4	Oct. 19, 1950, p. 62
105	5	Nov. 16, 1950, p. 266
106	2	Mar. 16, 1950, p. 72
107	1	Mar. 16, 1950, p. 75
108	4	Jan. 13, 1949, p. 83
109	3	Jan. 13, 1949, p. 87
110	5	Feb. 3, 1949, p. 87
111	4	Feb. 3, 1949, p. 88
112	5	Aug. 5, 1943, p. 28
113	2	Oct. 21, 1943, p. 63
114	1	Oct. 21, 1943, p. 64
115	4	Oct. 21, 1943, p. 64
116	3	Oct. 21, 1943, p. 63
117	5	Oct. 21, 1943, p. 63
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118	1	Nov. 2, 1950, p. 69
119	F	Nov. 2, 1950, p. 69
120	E	Nov. 2, 1950, p. 69
121	D	Nov. 2, 1950, p. 69
122	B	Nov. 2, 1950, p. 69
123	4	Sept. 28, 1946, p. 93, also Oct. 5, 1946, p. 80
124	5	Dec. 28, 1950, p. 78
125	3	Sept. 28, 1946, p. 93, also Oct. 5, 1946, p. 80
126	2	Mar. 23, 1950, p. 205
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127	2	Aug. 5, 1943, p. 29
128	5	Sept. 30, 1943, p. 34
129	3	Sept. 30, 1943, p. 34
130	4	Dec. 16, 1944, p. 107
131	1	Dec. 9, 1950, p. 182
132	5	Mar. 9, 1950, p. 97
133	5	Mar. 22, 1947, p. 290
134	4	Apr. 1, 1948, p. 275
135	3	Mar. 23, 1946, p. 113
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136	5	Aug. 23, 1947, p. 103
137	3	Aug. 23, 1947, p. 103
138	4	Mar. 3, 1949, p. 92
139	2	Dec. 14, 1946, p. 87
140	1	Mar. 23, 1950, p. 232
141	3	Feb. 2, 1950, p. 63
142	3	Feb. 2, 1950, p. 64
143	2	Mar. 23, 1950, p. 238
144	5	Mar. 23, 1950, p. 232
GEOGRAPHICAL		
145	4	July 27, 1950, p. 190
146	5	Mar. 29, 1951, also Dec. 21, 1950, p. 322
147	2	June 15, 1950, p. 105
148	2	Nov. 23, 1950, p. 113
CURRENT NEWS		
149	3	Aug. 10, 1950, p. 43
150	4	Nov. 23, 1950, p. 47
151	2	Mar. 30, 1950, p. 58
152	3	Apr. 13, 1950, p. 61
153	4	Mar. 16, 1950, p. 58
154	3	Jan. 4, 1951, p. 44
155	2	Aug. 10, 1950, p. 116
156	1	Nov. 23, 1950, p. 47
157	3	Nov. 16, 1950, p. 209
158	3	Nov. 2, 1950, p. 29
159	3	Apr. 13, 1950, p. 138
160	2	June 1, 1950, p. 33
161	5	Dec. 21, 1950, p. 172
162	2	Sept. 21, 1950, p. 170

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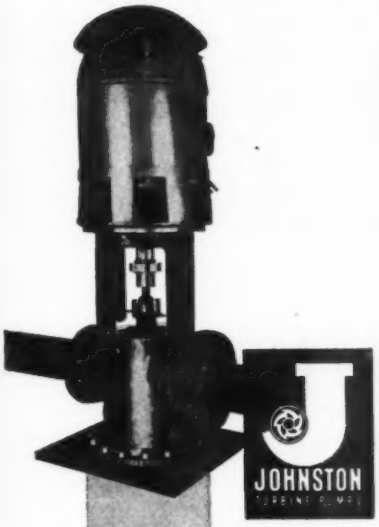

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1. **The supply vessel can be located wherever convenient and the pump bowls then set low enough for proper submergence.**
2. **Driver and piping connections are at the surface, eliminating dry sumps which are costly to build and expensive to maintain.**
3. **Nothing to lubricate but driver bearings.**
4. **Vertical design needs only ⅓ as much valuable floor space.**
5. **Due to diffuser type construction, this unit has higher efficiencies than conventional centrifugal pumps at high heads.**

Technical papers on the Johnston Volatile Liquid Pump are available. Send for as many copies as you need for interested personnel.

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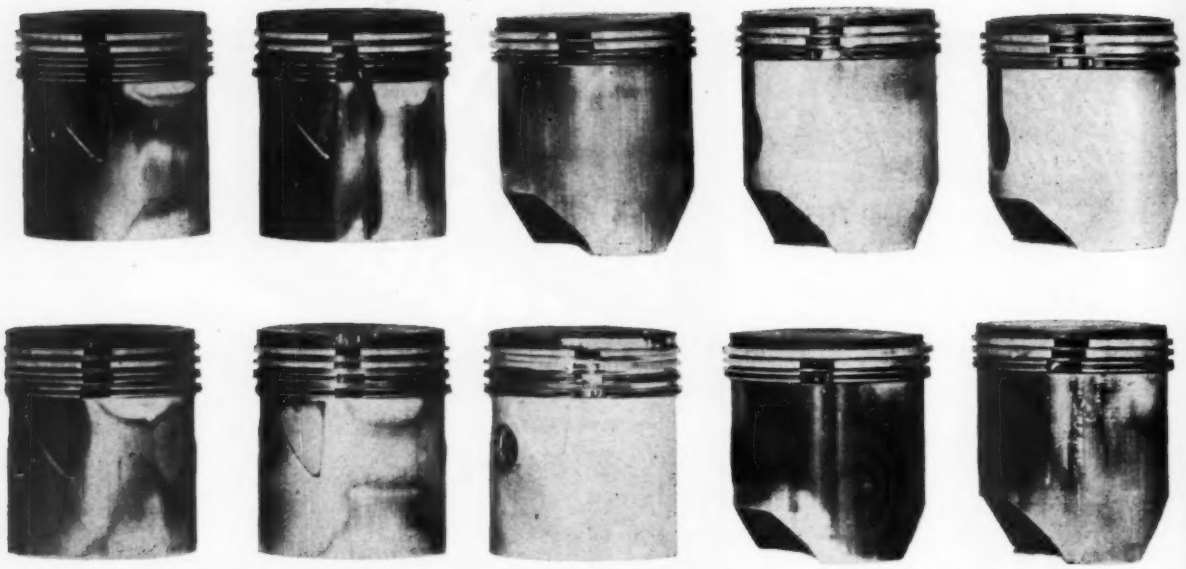

Figs. 1 and 2—Effect of detergent content on piston cleanliness in heavy-duty service (top) and door-to-door delivery service (bottom).

MOTOR-OIL ADDITIVES

Radioactive tracer technique for measuring engine wear should result in more rapid development of superior additives

by J. C. Geniesse* and W. Schreiber*

ADVANCES in engine design in the past two decades have resulted in widespread use of additives in motor oils because straight mineral oils fall far short of providing lubrication necessary to enable the operator to realize the maximum benefits from the improvements in the engines. The most recent advances have been in the direction of matching the additives, both inhibitor and detergent, with the fuel, engine, and operating conditions.

Lubricating-oil technologists recognizing the above factors have, in their research, made marked progress in developing special oils for varying types of service. This is economically feasible where specific equipment can be isolated for lubrication purposes and particularly where a large number of the same make of engines are used under similar conditions. In case of a mixed fleet, both as to type of equipment and mode of operation, the choice must be such as to provide the best lubrication from an over-all standpoint.

Oxidation and Corrosion Inhibition

Use of the alloy-type bearings such as copper-lead and cadmium-silver in many passenger cars, trucks, buses, and military vehicles has made it necessary to incorporate chemicals of the oxidation-corrosion inhibitor type into the oil in order to prevent corrosion of these bearings under high-temperature operating conditions. Compounds which have been used for this purpose are metal organodithio phosphates, alkylphenol sulfides, or organic phosphorus - sulfur compounds made by reacting certain types of hydrocarbons with phosphorus sulfides. It is generally believed that these compounds perform their function by one or more of the following mechanisms:

1. Deactivation of the metal surfaces in contact with the oil, such as iron and copper, which normally act as oxidation promoters.

2. Reaction with intermediate products of oxidation such as peroxides to retard the rate of the oxidation reaction.

3. Formation of a protective film over the bearings by controlled decomposition of the inhibitor.

Motor oils classified as premium type under the designation of the marketing division of the American Petroleum Institute generally contain the oxidation-corrosion inhibitor type of additive.

Detergency

The detergent - dispersant type of additive was first put into motor oils to take care of ring and piston deposits which were causing operating difficulties in high-speed diesel and heavy-duty commercial gasoline engines. These deposits result from contamination of the oil by soot, oxidized fuel residues, and some oil oxidation products. Under the high ring-belt temperatures the fuel and oil residues polymerize to form resins which separate out on the hot piston surfaces and other engine parts, and also bind the soot in the ring grooves, causing ring sticking. Accumulation of these deposits not only necessitates the expense of overhauling the engines but also means loss of revenue while the vehicle is idle. The use of the detergent-type oil eliminated a great deal of this type of trouble.

Some of the widely used types of detergents are metallic derivatives of: (1) sulfonates made either from petroleum fractions or from alkylated aromatic hydrocarbons; (2) alkylphenols; (3) alkylphenol sulfides. The most commonly used metals are the alkaline earths particularly calcium and barium although other metals such as potassium, magnesium, and cobalt have been or are being employed. There are several mechanisms by which the action of the detergent type of additive is explained. According to Prutton,[1] each particle of soot or sludge absorbs a large number of molecules of the detergent, thus preventing agglomeration and subse-

*Atlantic Refining Co.

quent deposition on the engine parts. Dennison and Clayton[2] propose the explanation that the resinous materials are condensed oxy-acids and that the metallic detergents react with these acids to prevent condensation. Typical reactions involving aluminum naphthenates are:

$$\text{Al (Naph)}_2\text{OH} + \text{H(OA)} \downarrow \text{Al (Naph) (OA)OH} + \text{H(Naph)}$$

$$\text{Al (Naph)}_2\text{OH} + 2\text{H(OA)} \downarrow \text{Al (OA)}_2\text{OH} + 2\text{H(Naph)}$$

It is probable that the sulfonates and other detergents react in a similar manner.

The superior qualities of the detergent-inhibitor type of oil was recognized in the adoption by the U. S. Army of this type of oil for all ground equipment. These oils were supplied under U. S. Army Specification 2-104B and were required to pass severe engine tests for detergency and for oxidation stability and bearing corrosion protection. They were found to be advantageous in both military equipment and commercial operations.

High-Additive-Content Oils

Recent developments of both fuels and engines have placed such increased demands on motor-oil quality that oils of far better quality than the 2-104B oils are required. This is particularly true in diesel-engine operation. Due to the large volume demand for diesel fuels refiners have had to utilize more components from each barrel of crude oil as well as higher-sulfur-content stocks. In some areas fuels with as much as 1 per cent sulfur are encountered. The effect of the higher sulfur content is to increase piston deposits because the sulfur oxides formed tend to accelerate the chemical reactions which result in ring sticking and varnish formation.

The sulfur oxides also increase piston ring and liner wear, particularly where jacket temperatures are low. Furthermore, increases in power output through supercharging in new engines developed by the diesel-engine manufacturers adversely affect the deposit problem because of the higher piston temperature obtained. A considerable amount of cooperative work was done by both engine manufacturers and petroleum refiners in order to find a solution to the problem and the result was the development of the Series 2 type of oil which contains much higher percentages of detergent than 2-104B oils. Furthermore a great many of these oils contain an alkaline type of detergent, the purpose of the alkalinity being to counteract the effects of the acidic products from fuel combustion.

Reports from many investigators have shown that the Series 2 oils have given excellent performance in field operation with respect to engine deposits and wear under severe fuel and operating conditions where 2-104B oils are unsatisfactory. The advantages in increased engine life and decreased down time under the above type of conditions have more than offset the higher cost of the oil.

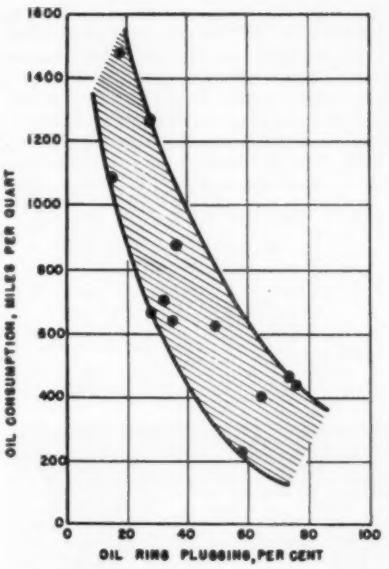

Fig. 3—Effect of oil-ring plugging on oil consumption for passenger cars in controlled road test.

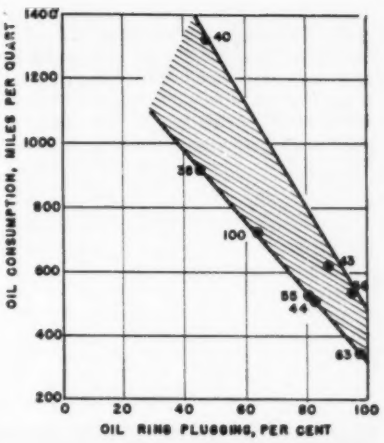

Fig. 4—Effect of oil-ring plugging on oil consumption for truck engines in heavy-duty intercity service. Figures on plotted points show test duration, thousands of miles.

In compounding the high-additive-content oils it was found absolutely necessary to balance the additive components in order to realize the maximum performance from the standpoint of deposits and wear without degrading the oil in other properties such as oxidation stability and bearing protection. The effectiveness of detergent content is shown in Figs. 1 and 2 taken from over-the-road and bakery-plant operation respectively. The piston on the extreme left represents the result obtained with a regular-grade oil and those following represent increasing detergent content as we move to the right. The piston on the extreme right is out of an engine which was run on a Series 2 quality oil.

Low-Temperature Detergency

Postwar research on motor oils has shown that the high speed and high temperature over the road operation is not necessarily the most severe from the standpoint of harmful engine deposits. A great deal of work on gasoline engines both in the laboratory and in the field has shown that the stop-start, warmup, or intermittent type of operation such as that encountered in light delivery trucks, taxicabs, and many passenger cars can result in much dirtier engines

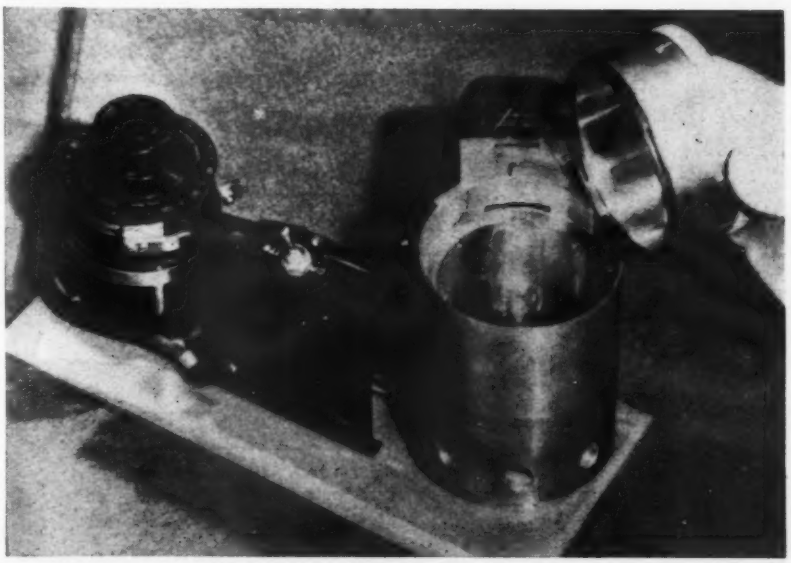

Fig. 5—Ring-plugging gage.

than high-temperature steady operation. The deposits formed are often referred to as low-temperature sludge and they are predominantly deposits from fuel because the engine temperatures are generally so low that oil oxidation is negligible. These products are frequently so large in quantity that they quickly overwhelm the detergent present in the average heavy-duty oil of the 2-104B type and settle in the oil-control rings thereby causing severe plugging.

The effect of high degree of oil-ring plugging is to markedly increase oil consumption which can be readily detected by the vehicle operator. This is due to the fact that oil rings are designed to return excess oil to the crankcase. If the oil ring is plugged the excess oil is burned. Since engine overhaul is most frequently based on oil consumption this property is very important. Fig. 3 shows the effect of oil-ring plugging on consumption for two makes of passenger cars used in a controlled road test under a light-duty type of operation.[6] Fig. 4 gives the same kind of information for a popular make of truck operated in intercity service.[5] Improvements in operations of this type have been obtained by the use of especially compounded oils of high detergent properties.

In a laboratory engine test, with an oil especially treated for low-temperature operation comparison was made with a 2-104B type heavy-duty oil. The higher-quality oil gave 24 per cent ring plugging while the 2-104B oil showed 93 per cent plugging. Results obtained in road operation substantiate these data. For example a popular make of passenger car was run for the first 14,000 miles under city type of operation using the 2-104B oil. At the end of this time the oil consumption was approximately 150 miles per quart. The engine was disassembled and showed 69 per cent ring plugging. New rings of the same type as those originally present were then installed and the vehicle continued in the same kind of operation but with the special low-temperature oil in the crankcase. At the end of another 14,000 miles the ring plugging was only 7 per cent and the oil consumption was 650 miles per quart.

While the improved oils play a most important part in the reduction of low-temperature deposits, maximum benefits can only be realized by taking into consideration fuel quality, engine design, and a good program of preventive maintenance. Methods of evaluating oils for low-temperature detergent quality have not reached the degree of standardization of that used for high-temperature detergency such as the C.R.C. Designation L-1 test, but considerable progress has been made. The C.R.C. FL-2 procedure which is a high-load, moderate-temperature test gives some measure of the varnish-forming tendency of fuels and the ability of oils to prevent deposition of varnish. Test and Hall[4] developed several laboratory cycling procedures which measure actual ring plugging under simulated light-duty operating conditions. The conditions for one of these tests is shown in Table 1.

A novel method for measuring ring plugging ratings is reported by Test and Hall.[4] The gage shown in Fig. 5 consists of a cylindrical base which supports an indexing turret containing the oil ring. The base also contains a photoelectric cell and a projection-type light bulb centered within the oil ring and turret. Light from the bulb passes through a given slot

TABLE 1—OIL-RING PLUGGING PROCEDURE FOR MULTICYLINDER ENGINE

Cycle—	2 hours at low speed*	3 hours at high speed
Load, b.hp.	2.9 ± 0.5	45 ± 1
Speed, r.p.m.	650 ± 50	2,500 ± 100
Air-fuel ratio	9.0 ± 0.5	13.5 ± 0.5
Jacket-water outlet temp., °F.	125 ± 3	190 ± 5
Carburetor air temp., °F.	Ambient	Ambient
Oil sump temp., °F.	(†)	235 ± 5
Oil sump charge, qt.	4	4
Gasoline required per test, gal.	250	250

*Every ½ hour, accelerate to 3,150 r.p.m. for 1 minute (to minimize spark-plug fouling). †Not controlled.

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in the oil ring, through a somewhat larger slot in the base and is picked up by the photoelectric cell. The amount of light reaching the photoelectric cell is inversely proportional to the amount of plugging in the ring slot. The turret is indexed so that a light-meter reading can readily be obtained on each slot in the oil ring. This gage is manufactured under license from Atlantic Refining Co. (U. S. Patent 2509316) by Engineering Research & Development Co., Hinsdale, Ill.

Rust Protection

Another phenomenon associated with low-temperature and warmup operation is that of rusting. Under this type of operation water from fuel combustion is condensed on the cylinder walls, piston rings, valve springs, and other parts of the engine where temperatures are low. In solution in the water are small amounts of acids which also result from fuel combustion such as sulfuric, carbonic, hydrobromic, etc. The water solution penetrates the oil film, resulting in corrosion of the iron with subsequent loss of metal and reduced engine life. When average trip length is low, engine wear is high, the wear decreasing as trip length is increased. Since a good deal of passenger-car operation is of the low-mileage per trip variety the need for combating this type of wear is evident. Considerable progress in this direction was made by addition of rust preventives to the motor oil. Some of the chemicals which have been found effective are metallic soaps, esters, and some phosphorus and nitrogen compounds. The generally accepted mechanism for the action of these rust preventives is that the chemical has a greater affinity for the metals than does water and is thus able to form a barrier which prevents penetration of water through the oil film. Data obtained in a single-cylinder engine run under low-temperature operating conditions showed a top ring weight loss of 60 mg. in 30 hours for an oil which had been treated with a rust preventive additive against 860 mg. for a straight mineral oil run for the same length of time.

Measurement of Wear by Use of Radioactive Tracers

Conventional tests for measuring wear are costly and time-consuming because the tests have to be run for a considerable length of time before the amount of wear is significant enough to be measured. Shortly before World War II the Atlantic Research Laboratory developed the radioactive tracer technique which provided a method for measuring wear rapidly and accurately. The metal whose wear characteristics were to be measured was rendered radioactive and when the metal was subjected to the conditions of the wear test the radioactive debris entered the oil and the amount of wear was determined by measurement of the radioactivity of the oil by means of a Geiger counter. U. S. Patent 2315845 issued in 1943 describes this technique. The method possesses the added advantage that wear rate can be determined at any point in the test without disturbing the equipment.

Within the past few years the uranium chain reacting pile at Oak Ridge has been made available to industry by the Isotopes Division of the Atomic Energy Commission, making it possible to utilize this method as a practical research tool. Pinotti et al[5] have studied wear rates in engines using irradiated piston rings and have reported excellent correlation between wear calculated from radioactivity measurement and actual ring weight loss.

Railroad Diesel Lubricating Oil

The use of diesel locomotives for railroads especially for heavy-duty over-the-road service has increased tremendously over the past few years. Some of the advantages of diesel power over the steam locomotives are fuel and operating economy, and smoke abatement. During the war years most of the diesel engines used by the railroads were employed in switchers where lubrication requirements were not severe but with the

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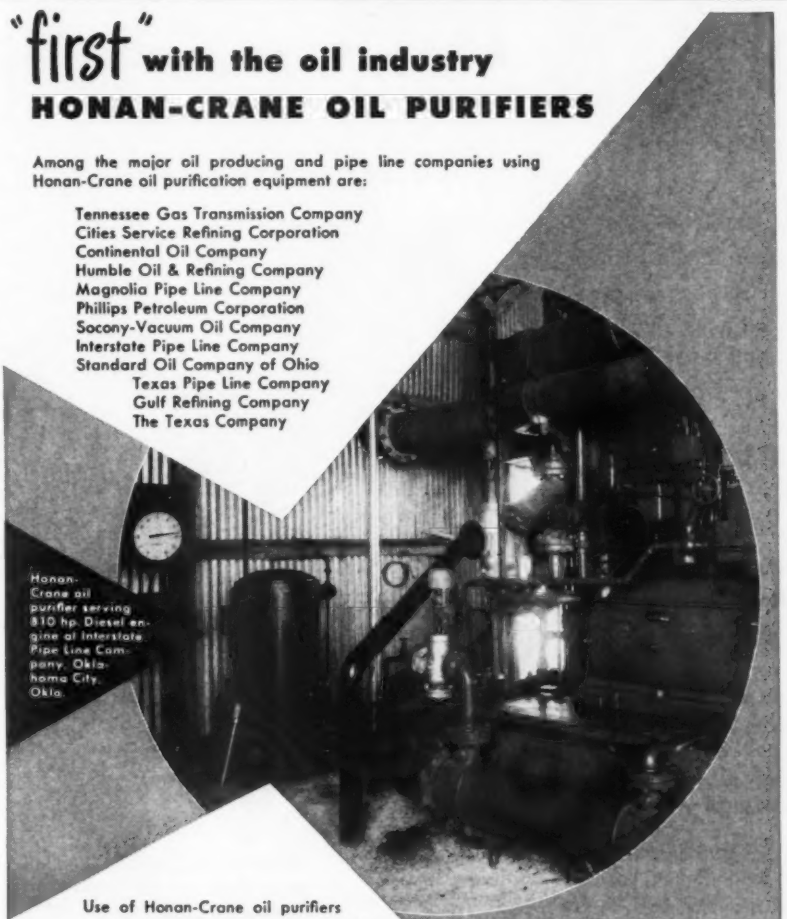

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increased use of diesels for over-the-road freight and passenger service the problem of oil oxidation and engine deposits has become critical.

The petroleum industry's answer to the foregoing problem was the detergent-inhibitor type of oil. Because the General Motors EMD engines which represent a large proportion of the railroad diesel engines in service are equipped with silver-plated wrist-pin bushings, an additional requirement placed on the oil was that it must not be corrosive to silver. This eliminated many of the heavy-duty 2-104B oils because they were unable to meet this requirement. A comparison of a commercial oil 2-104B oil with an accepted railroad diesel lubricating oil with respect to corrosion of silver is shown in Table 2. The test is run

TABLE 2—SILVER CORROSION TEST
(72 hours at 300° F., stirring rate 300 r.p.m.)

Oil—	Weight change (mg.)	Appearance of silver
Commercial 2-104B oil	139.0	Dark gray-blue coating
Approved railroad diesel lubricating oil	0.8	Gray stain

by subjecting the oil in a beaker to a temperature of 300° F. with stirring in the presence of a silver and a copper strip for 72 hours. Evaluation is made on the basis of the weight change and appearance of the silver strip.

In addition to the above test, the General Motors Research Laboratory also evaluates the oils on the basis of a bearing test which is known as the OM-2 test. Oils are evaluated on the basis of weight loss and temperature rise of the bearing. In this test not only the chemical activity but also actual lubricating ability is measured.

In approving oils the railroads take into consideration the above tests and also other screening tests for oxidation stability, detergency, etc., but final approval is contingent upon actual performance on the road over a considerable period of time.

What Lies Ahead

Most of the problems of the immediate future will revolve around increased compression ratio and higher output engines. The necessity of keeping down octane requirement, spark-plug fouling, and valve burning will assume greater importance if full benefit from these engine improvements is to be realized. Evidence at present indicates that oils differ with respect to the above factors and a great deal of work lies ahead on the study of these factors and the most satisfactory lubricants for taking care of them.

More rapid development of superior additives for reduction of engine wear is probable now that the radioactive tracer technique for measuring wear is available.

It is expected that silver bearings will come into greater use in military equipment which means that military oils will probably be required to possess corrosion resistance to silver. Experience gained in the work on railroad diesel lubricating oils represent progress in this direction.

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Characteristics of Crude Oils Currently Produced in the United States

by Harold M. Smith*

The crude-oil-producing areas of the United States are divided into eight geographical areas, and certain characteristics of the crude oils produced in each area are discussed. Characteristics, based on Bureau of Mines routine analysis, include the contents of sulfur, asphalt, naphtha, gas oil, aromatics in both the naphthas and gas oils, and naphthene ring in the paraffin-naphthene portions of both the naphthas and the gas oils. A total of 330 crude oils are considered in the discussion.

THIS review of crude oils currently being produced throughout the United States discusses certain characteristics of the oils from each of eight geographical areas of the country. These areas are (1) California; (2) Rocky Mountain (includes Colorado, Wyoming, and Montana); (3) West Texas (includes what is usually termed "West Texas" and the adjacent fields in New Mexico, the Texas Panhandle, and the newly discovered Scurry County district of Texas); (4) Gulf Coast (a belt approximately 50 miles wide along the Texas and Louisiana Gulf Coast); (5) Mid-Continent (includes all of Texas not included in West Texas or Gulf Coast, and all of Oklahoma, Kansas, Arkansas, and Illinois, as well as southwest Indiana and northern Louisiana); (6) Mississippi (includes one field in Alabama); (7) Michigan (includes Ohio and Indiana); and (8) Appalachian (Pennsylvania, New York, and West Virginia, as well as eastern Ohio and Kentucky).

In all, 330 crude oils have been considered in making this review. Most of the analyses used have been published in compilations covering the entire country[28 32] or in separate reports for certain areas that will be indicated by references during the discussion of those areas.

*Bureau of Mines, Petroleum Experiment Station, Bartlesville, Okla.

Characteristics Considered

The characteristics of the crude oils that have been considered in this review are the contents of sulfur, asphalt, naphtha, gas oil, aromatics in both the naphthas and the gas oils, and naphthene ring in the paraffin-naphthene portions (P-N) of both the naphthas and the gas oils. This makes a total of eight categories, which are defined in more detail as follows:

Sulfur.—This is weight-per cent total sulfur in the crude oil. The distribution of this sulfur in the crude oil as elemental sulfur and in sulfur compounds is discussed in other papers.[1 34]

Asphalt.—This is the content of 100-penetration (at 77° F.) asphalt. It is estimated from data presented by Stanfield and Hubbard,[37] which indicate that the percentage asphalt of this penetration can be approximated for comparative purposes by multiplying the carbon residue of the crude oil by 4.90.

Naphtha.—The naphtha content is the total distillate received in a Bureau of Mines routine analysis[21] at a vapor temperature of 200° C. (392° F.). It includes the first seven fractions obtained by this method of distillation.

Gas oil.—This is considered to be the material distilling between 200° C. (392° F.) at atmospheric pressure and 225° C. (437° F.) at 40 mm. This represents fractions 8, 9, and 10 of the B. of M. routine distillation[21] obtained at atmospheric pressure, and fractions 11 and 12, which are obtained at 40-mm. pressure.

Aromatics.—The aromatic contents of both the naphthas and gas oils were estimated by a method developed by McKinney and others and reported in B. of M. Technical Paper 722.[35] The basic data used in developing the correlations from which the estimates were made were obtained on 10 crude oils of widely different types and sources, and the correlation of the estimated values and the determined values is fair. The author believes that the aromatic-content figures given or used in this report are probably accurate within plus or minus 10 per cent, which is satisfactory for the purpose of this review.

Ring content.—The value used for reporting ring content is weight-per cent ring in the paraffin and naphthene portions; that is, the entire naphthas or gas oils from which the estimated aromatic contents have been subtracted. Because of lack of information concerning the type of naphthenes present, it is impossible to convert from weight-per cent naphthene ring to volume per cent naphthenes from data now available. The weight-per cent naphthene ring has been estimated from a correlation between the average weight-per cent naphthene ring[27] and the weighted average correlation index for the paraffin-naphthene portions of each naphtha and each gas oil according to a method described in a paper presented before the American Chem-

TABLE 1—UNITED STATES CRUDE OIL PRODUCTION COVERED BY THIS STUDY

Area—	U.S. prod. in area (%)	Represented by analyses: Area prod. (%)	Represented by analyses: No. of fields
California	15.55	92	58
Rocky Mountain	4.45	62	17
West Texas	21.15	63	45
Gulf Coast	22.20	64	102
Mid-Continent	32.81	54	88
Mississippi	1.90	89	9
Michigan	0.88	40	9
Appalachian	1.06	78	2

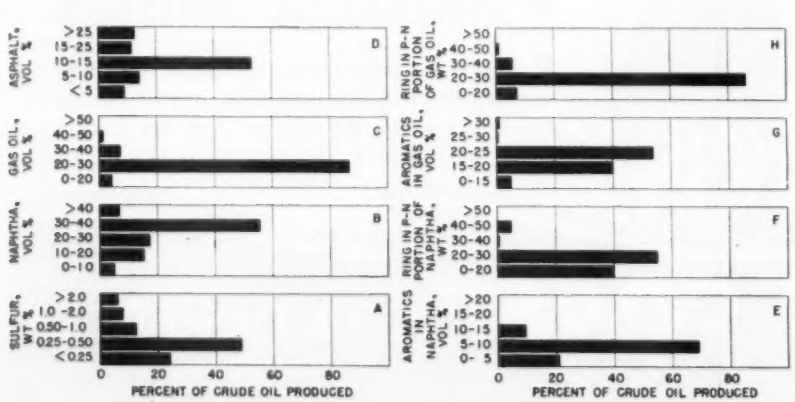

Fig. 1—Distribution of components of Mid-Continent crude oils.

ical Society in Cleveland in April 1951.[28]

Mid-Continent Crude Oils

Comparison of the properties of the crude oils[5 6 7 9 10 11 17 22 23 25 34] of the Mid-Continent area is shown by a series of bar graphs in Fig. 1. There are eight series of bar graphs, A to H, each corresponding to one of the properties under consideration. The abscissa of each bar graph is the percentage of crude oil produced in the area, and the ordinates of the bar graph are the several percentage classes into which each category or property has been divided.

Sulfur content.—The sulfur content has been divided into the following groups by weight per cent: Less than 0.25, 0.25-0.50, 0.50-1.0, 1.0-2.0, and greater than 2.0. Fig. 1 indicates that approximately 24 per cent of the crude oil produced in the Mid-Continent area contains less than 0.25 weight per cent sulfur, and that 49 per cent of the crude oil produced falls in the sulfur-content range of 0.25 to 0.50. Thus, almost 75 per cent of the crude oil produced in the Mid-Continent area might be termed low-sulfur crude oil. This includes production from such important fields as West Edmond and Oklahoma City in Oklahoma; Delhi and St. John in Louisiana; Clay City, Louden, and Salem in Illinois; Kraft-Prusa, Silica, and Trapp in Kansas; and KMA and East Texas in Texas.

The production of crude oils with a higher content of sulfur is somewhat localized. For example, southern Oklahoma contributes crude oil from the Velma, Tatum, and Scholem Alechem fields in the high-sulfur category; a few of the western Kansas fields produce oil in the range of 0.5 to 1.0 per cent sulfur; crude oil from some of the Texas fields such as Van, Talco, and Hawkins have from 1.0 to more than 2 per cent sulfur; a few fields in Arkansas, such as Magnolia, and Hainesville in northern Louisiana, along with Smackover in Arkansas, produce oil in the high-sulfur group.

Thus, in general the high-sulfur oils in the Mid-Continent area may be said to be in Arkansas, northern Louisiana, southern Oklahoma, and eastern Texas, with, of course, a few scattered independent fields occurring at widely separated intervals.

Naphtha content.—Turning now to the naphtha content of Mid-Continent crude oils, with the exception of a few, such as those from Van in Texas, Smackover in Arkansas, and Scholem Alechem in Oklahoma, which are deficient in naphtha, these oils contain 10 to 40 per cent naphtha. By far the biggest group, approximately 55 per cent, falls in the range 30 to 40 per cent of naphtha. A few of the Kansas fields, such as Silica and Kraft-Prusa, exceed this figure.

Gas-oil content.—Mid-Continent crude oils are remarkably constant relative to gas-oil content, and about 87 per cent of the oil produced contains between 20 and 30 per cent of this fraction.

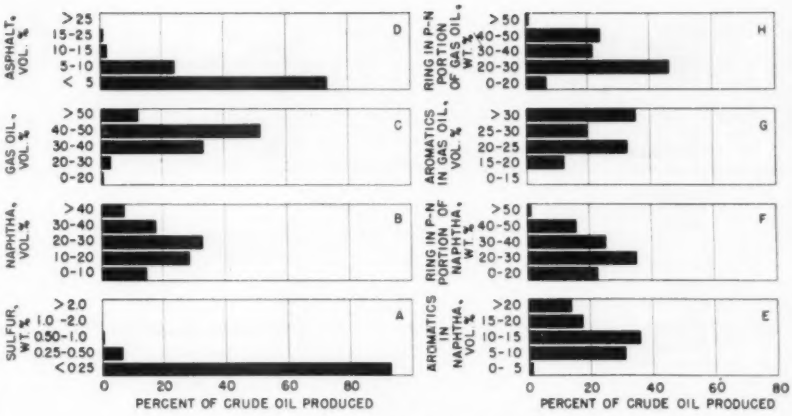

Fig. 2—Distribution of components of Gulf Coast crude oils.

Asphalt content.—Over 50 per cent of the crude oils yield 10 to 15 per cent asphalt, and the remaining 50 per cent are fairly evenly divided on both sides of this group. Certain fields, such as Smackover in Arkansas, Scholem Alechem and Tatums in Oklahoma, and Hawkins in Texas, produce crude oils having more than 25 per cent asphalt.

Aromatics in naphtha.—Turning now to the actual chemical composition of the crude oils, the aromatic contents of the naphthas are relatively low; about 20 per cent of the naphthas are in the range 0-5 per cent aromatic, and 70 per cent are in the range 5-10 per cent; only a few fields, such as Caddo in Arkansas and Cement and Velma in Oklahoma, yield naphthas having 10 to 15 per cent aromatics. None of the crude oils studied contained more than 15 per cent aromatics in the naphtha fraction.

Ring content of paraffin-naphtha portion of naphtha.—These naphthas from the Mid-Continent crude oils are fairly evenly divided between the 20-30 and 30-40 per cent classes, and these two classes account for about 95 per cent of the crude oil. Again, crude oils from Velma in Oklahoma and Smackover in Arkansas appear to be somewhat different, in that they yield naphthas having 40 to 50 per cent of naphthene ring.

Aromatic content of gas-oil.—From a given crude oil this is almost always higher than the aromatic content of the naphtha from the same oil, and in conformance with this the aromatic contents of the gas oils lie in the 15-20 and 20-25 per cent classes, and these two classes account for more than 90 per cent of the crude oil produced in the Mid-Continent area.

Ring content in the paraffin-naphthene portion of gas oils.—The content of naphthene ring is very constant. Over 90 per cent of the crude oils yielded gas oils that had 20 to 30 per cent naphthene ring, with a small proportion in the class immediately adjacent to this on each side.

These properties of Mid-Continent oils are of interest in themselves, but they become of more interest when compared with the other areas. In particular, comparisons with the adjacent Gulf Coast and West Texas areas are of interest as showing the differences that can be localized in the various areas to a considerable extent.

Comparison of Gulf Coast Crude Oils

Comparisons of the properties of Gulf Coast crude oils[2 11 16 17 22 25] are given in the bar graphs of Fig. 2.

Sulfur content.—One of the distinguishing features of Gulf Coast crude oils is their low sulfur content, as 93 per cent of the oil produced has less than 0.25 per cent sulfur, and virtually all of the remaining crude oil has less than 0.5 per cent sulfur. Many of the fields that have the higher content of sulfur are in Louisiana, such as Leesville, West Hackberry, and Bay St. Elaine, along with Willamar field in Texas.

Naphtha content.—Generally speaking, the naphtha content of Gulf Coast oils is somewhat less than for crude oils from most other sections of the country. Thus, approximately 45 per cent of the crude oil produced contains less than 20 per cent of naphtha. There are, however, a few fields that produce crude oils having 30 to 40 or an even higher percentage of naphtha.

Gas-oil content.—In contrast to the naphtha content of Gulf Coast crude oils, the gas-oil content is exceptionally high, and about 95 per cent of the crude oil produced contains 30 or more per cent gas oil, with a considerable portion in the 40-50 percentage range or some even above 50 per cent.

Asphalt content.—As might be expected from the low sulfur content, the asphalt content of Gulf Coast crude oils is very low, about 75 per cent having less than 5 per cent asphalt and most of the remaining oils being in the 5-10 per cent range. One

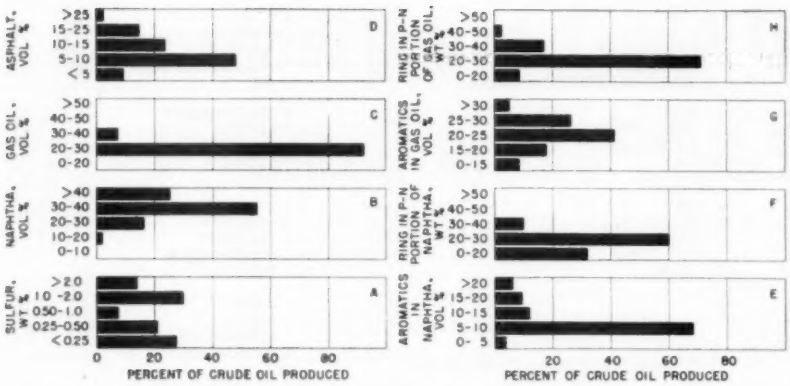

Fig. 3—Distribution of components of West Texas crude oils.

field, Willamar, is in the 10-15 per cent asphalt category.

Aromatic content of the naphtha.—The Gulf Coast area is one of the few sources in the country of crude oils that contain appreciable quantities of aromatic hydrocarbons, even in the naphthas. Thus, about 30 per cent of the naphthas contain 5-10 per cent aromatics, 35 per cent contain 10-15, and another 30 per cent contain more than 15 per cent aromatics. Those fields that produce crude oils having naphthas with 15 or more per cent aromatics are Conroe, West Columbia, Sugar Valley, Sheridan, Stowell, Old Ocean, Seeligson, Kelsey, Fairbanks, Tomball, and Silsbee, in Texas; and West Cote Blanche Bay, Bayou Sale, Iowa, Quarantine Bay, Egan, Golden Meadow, and Lake Salvador in Louisiana.

Ring content of paraffin-naphthene portion of naphtha.—Gulf Coast crude oils long have been considered as naphthenic oils, and one reason for this can be seen in the ring contents of the paraffin-naphthene portion of the naphthas. Although fairly evenly divided from the 0-20 per cent class to the 40-50 per cent class, there is probably a preponderance of naphtha produced having 30 per cent or more of naphthene ring in the paraffin-naphthene portion, with a considerable proportion in the 40-50 per cent class.

Aromatic content of gas oils.—In keeping with the fact that the naphthas have fairly high contents of aromatics, the aromatic contents of the gas oils also are high, and 45 per cent of the crude oils produced will yield gas oils having 30 per cent or more of aromatic content.

Ring content of paraffin-naphthene portion of gas oil.—About half of the crude oil produced yields a gas oil, the paraffin-naphthene portion of which contains 30 to 50 per cent naphthene ring. Most of the other gas oils contain 20 to 30 weight per cent ring in the paraffin-naphthene portions.

Comparison of these crude oils with Mid-Continent oils shows a definite segregation in the Gulf Coast area of the low-sulfur type of oil, with a correspondingly low content of asphalt, a somewhat lower naphtha content, and a considerably higher gas-oil content. Both the naphthas and the gas oils contain appreciably more aromatics and more naphthene rings than the majority of the oils found in the Mid-Continent area or in any other area of the country, with the exception of the high naphthene ring content found in California oils. But the California oils as a class do not yields naphthas with as high an aromatic content as may be expected to be found in a Gulf Coast crude oil. However, the presence of aromatics in the naphthas seems to be somewhat unpredictable, and one occasionally finds a high aromatic crude oil where ordinarily it would not be expected.

Comparison of West Texas Crude Oils

The essential data for West Texas crude oils[13 17 18 19 20 21] are shown in the bar graphs of Fig. 3.

Sulfur content.—For a number of years West Texas crude oils and high-sulfur crude oils have been more or less synonymous terms, but within the last few years, particularly within the last year, this situation has changed, and at present almost 50 per cent of the oil produced in West Texas contains less than 0.5 per cent sulfur. These low-sulfur oils are produced almost exclusively in the Ellenburger formations at various points in West Texas, and particularly from the Canyon Reef formation in Scurry County and adjacent areas. As shown in the bar graph, considerable crude oil is produced having a sulfur content of 1 per cent or more, and some of the largest fields in West Texas, such as Slaughter, Wasson, and Goldsmith, are in this high-sulfur category. In general, the sulfur compounds[13 14] found in West Texas crude oils are the straight-chain type rather than the cyclic type found in Rocky Mountain and California crude oils and as such are more amenable to treatment by some of the processes designed for the removal of mercaptans and sulfides.

Naphtha content.—West Texas oils are somewhat higher in naphtha content than the average for the country. Approximately 55 per cent of them contain 30 to 40 per cent naphtha, another 25 per cent yield over 40 per cent, and there are none that have less than 10 per cent. This characteristic, of course, makes them attractive crude oils.

Gas-oil content.—The West Texas crude oils are found almost universally to run between 20 and 30 per cent gas-oil content, with a small amount of crude oil yielding 30 to 40 per cent gas oil.

Asphalt content.—Possibly because the sulfur compounds are not as predominantly cyclic as in Rocky Mountain and California crude oils, the asphalt content of West Texas is not as high as would be expected from casual inspection of the sulfur content of many of these crude oils. For example, approximately 50 per cent of the crude oil produced contains only 5 to 10 per cent of asphalt, and, even assuming that this is accounted for by the low-sulfur crude oils, the crude oils having asphalt contents of 15 per cent and more constitute only about 20 per cent of the total. It is interesting to compare these oils and those of California on this basis.

Aromatics in naphtha.—This follows fairly well the pattern for most of the country, with the exception of those from the Gulf Coast. Almost 70 per cent of the crude oils yield a naphtha having 5 to 10 per cent aromatics. However, there are some crude oils that contain rather large quantities of aromatics, such as the Slaughter and Wasson crude oils, the former containing over 1½ per cent each of benzene and toluene, and the graph shows that 15 per cent of the crude oils yield naphthas that contain 15 or more per cent of aromatics.

Rings in paraffin-naphthene portion of naphtha.—The ring content of the naphtha from West Texas crude oils centers predominantly about a paraffin-naphthene portion containing 20 to 30 per cent ring, but about 30 per cent of the naphthas have less than 20 per cent of naphthene ring in the paraffin-naphthene portion. This is a slightly higher ring content than is generally found for Mid-Continent naphthas but less than for Gulf Coast naphthas and decidedly less than for the California naphthas.

Aromatic content of gas oil.—West Texas crude oils yield gas oils that are fairly aromatic, as 70 per cent of the gas oils will contain 20 or more per cent of aromatics and 30 per cent will contain more than 25 per cent aromatics.

Ring content of paraffin-naphthene portion of gas oil.—These portions of gas oils from West Texas crude oils are predominantly in the 20-30 weight per cent ring range, few crude oils having a somewhat higher range. Almost none of the crude oils have more than 40 per cent ring and only a small percentage have less than 20 per cent. In this respect they are quite similar to Mid-Continent crude

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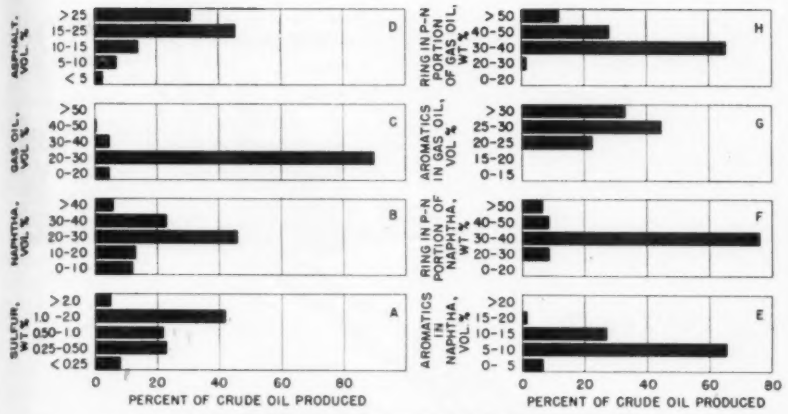

Fig. 4—Distribution of components of California crude oils.

oils and less naphthenic than the Gulf Coast and California oils.

Comparison of California Crude Oils

The essential data for California crude oils[15 19 20 21 24 38] are shown in the bar graphs of Fig. 4.

Sulfur content. — California crude oils have long been known for their content of sulfur, and the bar graph shows why. About 70 per cent of the oil produced has a sulfur content of 0.5 or greater, 40 per cent has 1.0-2.0 per cent sulfur, and 5 per cent has more than 2.0 per cent. Crude oils that have a low-sulfur content are consequently of interest in California, and some of the important fields having less than 0.25 per cent sulfur are Rio Bravo, Paloma, Cymric, Santa Fe Springs, Riverdale, and Richfield; some having 0.25-0.50 per cent sulfur are Coalinga, Kettleman North Dome, Greely, and Russell Ranch. The highest sulfur content for a crude oil that the bureau has ever found for United States production is a crude oil from Oxnard field in Ventura County, which had a sulfur content of 7.5 per cent.

Naphtha content.—California crude oils are largely in the 20-30 percentage naphtha content range, but an appreciable amount is in the 30-40 percentage range. There are a number of very heavy high-sulfur oils in California that are deficient in naphtha, and these account for the more than 10 per cent of crude oil having only 0-10 per cent naphtha.

Gas-oil content.—Ninety per cent of the crude oils produced yield 20 to 30 per cent of gas oil. Most of the remaining 10 per cent are evenly divided on each side of this class.

Asphalt content.—In keeping with the high-sulfur content of the California oils and also with a relatively high nitrogen content,[4] which ranges from 0.1 to 0.5 per cent, the crude oils contain a high proportion of asphalt, and 75 per cent of them contain 15 per cent or more asphalt. About 30 per cent of the crude oil contains more than 25 per cent asphalt.

Aromatics in naphtha.—The percentage of aromatics in the naphtha from California crude oils is not as high as is ordinarily expected. They are more like the Mid-Continent oils in this respect than, for example, those from the Gulf Coast. About 65 per cent of the oils yield naphthas having only 5 to 10 per cent aromatics; about 30 per cent have 10 to 15 per cent aromatics; and these two classes contain virtually all of the crude oils except for a small amount containing 0 to 5 per cent aromatics.

Rings in paraffin-naphthene portion of naphtha.—The naphthene-ring content of the paraffin-naphthene portion of these California naphthas is relatively high, and about 75 per cent of the naphtha produced contains 30 to 40 per cent naphthene ring. A number of naphthas also are produced in which the paraffin-naphthene portions contain 40 or more per cent of naphthene ring. Some of the fields from which such crude oils are produced are Lost Hills, Raisin City, East Coyote, Englewood, Midway-Sunset, Bell Ridge, Buena Vista, and Fruitvale.

Aromatic content of gas oil. — In contrast to the rather low aromatic content of the naphtha, the aromatic content of the California gas oils is exceedingly high. All of them contain 20 per cent or more, more than 30 per cent of the crude oils yield gas oils having more than 30 per cent of aromatics, and more than 40 per cent of the gas oils contain from 25 to 30 per cent of aromatics.

Ring content of paraffin-naphthene portion of gas oil.—The paraffin-naphthene portions of the gas oils contain large proportions of naphthene ring. Sixty-five per cent of the gas oils will have a paraffin-naphthene portion containing 30-40 per cent ring, 35 per cent will have more than 40 per cent ring, with an appreciable quantity having more than 50 per cent of naphthene ring.

California oils as a group are typified by medium to high-sulfur content with a few exceptions; by a fairly high naphtha content in many instances, but there are many crude oils with very low naphtha content; a nominal gas oil content which is in line with the rest of the country with the exception of the Gulf Coast; a high content of asphalt; a rather low content of aromatics in the naphtha, but this content increases rapidly and becomes high in the gas-oil fraction; and both the naphthas and gas oils are characterized by a relatively large content of naphthene ring in the P-N portions.

Comparison of Rocky Mountain Crude Oils

The essential data for the Rocky Mountain crude oils[2 3 25 29 33] are shown in the bar graphs of Fig. 5 and discussed below:

Sulfur content. — Rocky Mountain crude oils, particularly those of Wyoming, for some time have been known for their high content of sulfur, and this is well illustrated in the bar graph, which shows almost 80 per cent of the oils having 0.5 per cent sulfur or higher. However, there are a few important oil fields that produce low-sulfur crude oil, such as Salt Creek and Lance Creek, Wyoming, and Wilson Creek, Colorado. Rangely, Colorado, and Cutbank, Wyoming, are in the 0.5-1.0 per cent classification, and Elk Basin, Wyoming, is in the 1.0-2.0 per cent class.

Naphtha content. — Most of the Rocky Mountain oils have a fairly

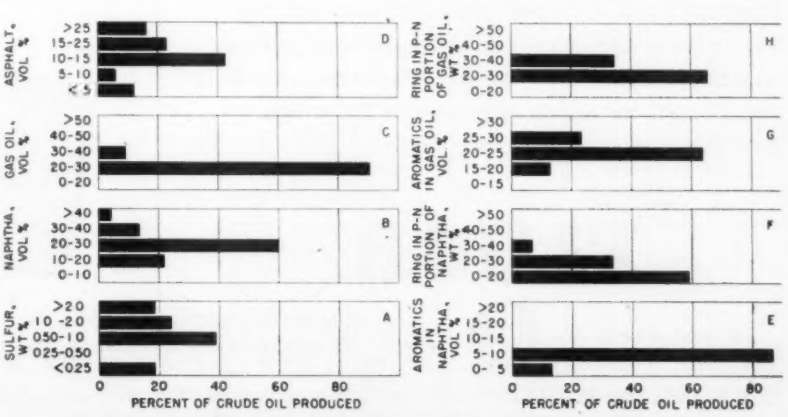

Fig. 5—Distribution of components of Rocky Mountain crude oils.

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high content of naphtha, 60 per cent being in the 20-30 per cent naphtha range, with all of them showing 10 per cent or more naphtha.

Gas-oil content.—This is typical of United States crude oils, better than 90 per cent of the oil produced yielding 20 to 30 per cent gas oil.

Asphalt content.—As might be expected from the relatively high sulfur content, Wyoming crude oils are noted for their asphalt content, and about 80 per cent of the crude oil produced contains more than 10 per cent of asphalt, 23 per cent is in the 15-25 per cent asphalt classification, and over 15 per cent contains more than 25 per cent asphalt.

Aromatic content of naphtha.—The aromatic content of the naphthas from Rocky Mountain crude oils is low, almost 90 per cent being in the 5-10 per cent class and none higher than that.

Ring content of paraffin-naphthene portions of the naphtha.—These portions of the naphthas from these Rocky Mountain crude oils are also rather low, almost 60 per cent of the P-N portion containing 0 to 20 per cent ring, and most of the remaining oils falling in the 20-30 per cent class. When this fact is linked with the low-aromatic content, which means a large paraffin-naphthene portion, it is evident that these oils contain a large percentage of paraffin hydrocarbons.

Aromatic content of gas oil. — As with the naphthas, the aromatic content of the gas oil does not increase greatly. Approximately 65 per cent of the gas oils produced contain 20 to 25 per cent aromatics, and a little over 20 per cent of the crude oil yields gas oils having 25 to 30 per cent aromatics, but there are none that have over 30 per cent aromatics.

Ring content of paraffin-naphthene portion of a gas oil.—The ring content of the P-N portions of these gas oils is much lower than for corresponding fractions from many other United States crude oils. Sixty-five per cent of the crude oils yield gas oils containing only 20 to 30 per cent of ring, and the rest have only 30 to 40 per cent, with none higher. This, again, as in the case of the naphtha, evidences a relatively large proportion of paraffin hydrocarbons in the gas oil.

Rocky Mountain crude oils are characterized by either a relatively high content of sulfur or a low content of sulfur; the naphtha and gas oil contents are nominal and in keeping with other United States crude oils; the asphalt content, in keeping with the sulfur, is high, except for those few low-sulfur crude oils; the aromatic contents of both the naphthas and gas oils are low; the naphthene-ring content of the paraffin-naphthene portions in both naphthas and gas oils is low, with the result that paraffin hydrocarbons are present to a large extent. These crude oils have a rather peculiar combination of characteristics involving high contents of sulfur and asphalt, low contents of aromatics and naphthenes, and relatively large quantities of paraffins.

Mississippi, Michigan, and Appalachian Crude Oils

The contribution of each of these areas to the total production of the country is a little less than 4 per cent, and no graphs are given for these crude oils.[9 12 25 28]

Sulfur content.—Mississippi crude oils are about evenly divided between very low (under 0.25), 0.5-1.0, and over 2.0 per cent sulfur content. Michigan crude oils are about evenly divided between those having over 0.5 per cent sulfur and those having less, whereas the Appalachian crude oils uniformly have less than 0.25 per cent sulfur.

Naphtha content.—Mississippi oils are rather varied, some 30 per cent having less than 10 per cent naphtha, and about 40 per cent having 30 to 40 per cent naphtha, remaining crude oils falling between these two classes. Michigan oils are typified by having relatively high contents of naphtha, better than 40 per cent having 40 per cent naphtha, and the remainder of the crude oils having 20 to 40 per cent naphtha. The Appa-

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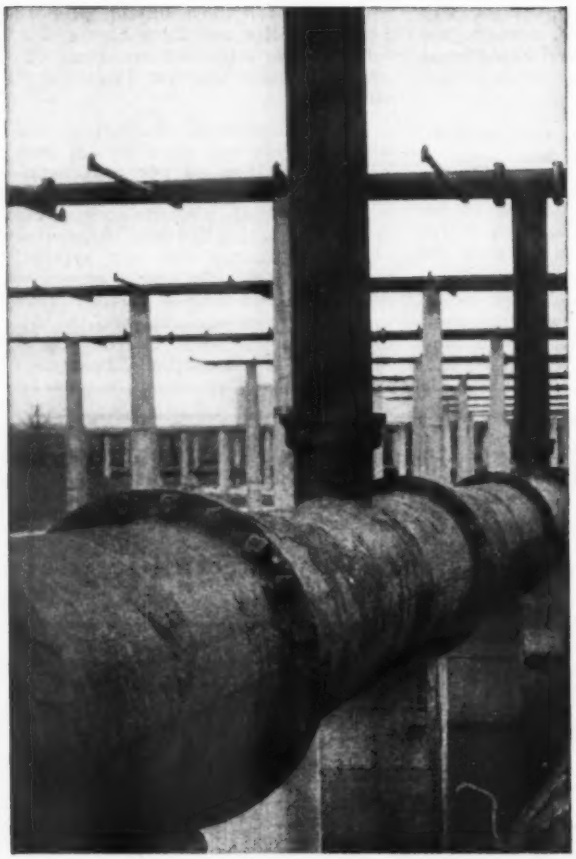

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lachian oils uniformly have 30 to 40 per cent naphtha.

Gas-oil content. — Mississippi and the Appalachian area crude oils are the same as most of the country—in the range 20 to 30 per cent gas-oil content. However, about 30 per cent of the Michigan oils yield 30 to 40 per cent gas oil.

Asphalt content.—Mississippi oils is relatively high, almost 50 per cent having more than 25 per cent asphalt and 10 per cent having 15 to 25 per cent. The remaining oils contain 0 to 10 per cent asphalt.

Michigan oils on the whole are fairly low in asphalt content, better than 60 per cent containing less than 10 per cent asphalt, and only a very small proportion containing more than 25 per cent. The Appalachian oils all have less than 5 per cent.

Aromatic content of naphtha.—Mississippi naphthas are characterized by very low aromatic contents, about 70 per cent having less than 5 per cent aromatics, 10 per cent having 5 to 10 per cent, and the remainder having 10 to 15 per cent. Michigan crude oils are characterized largely by naphthas having 5 to 10 per cent aromatics, about 10 per cent falling in the 10-15 per cent aromatic class. On the contrary, about 75 per cent of the Appalachian oils yield naphthas with an aromatic content of 10 to 15 per cent, and the rest are in the 5-10 per cent classification.

Ring content of paraffin-naphthene portion of naphthas.—The P-N portions of the naphthas from the Mississippi, Michigan, and Appalachian crude oils are singularly alike, in that their ring content is low—less than 20 per cent in most instances, with a few Michigan naphthas having 30 to 40 per cent.

Aromatic content of gas oils.—Mississippi, Michigan, and Appalachian crude oils is relatively low; about 70 per cent of the Mississippi gas oil contains 15 to 20 per cent of aromatics; almost 85 per cent of the Michigan oil contains less than 20 per cent aromatics, 50 per cent having less than 15 per cent aromatics; and the Appalachian area contains fairly uniformly 15 to 20 per cent aromatics.

Ring content of paraffin-naphthene portion of gas oil.—As in the case of the naphthas, the ring content of the P-N portions of the gas oils from Mississippi, Michigan, and Appalachian crude oils is low. The Mississippi oil yields paraffin-naphthene portions containing 20 to 30 per cent of ring, whereas most Michigan and Appalachian oils contain less than 20 per cent ring.

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Sohio's Construction Program

(Continued from page 225)

protection is afforded from surges in the power system which could damage the machines.

It is of interest to note that on July 19, 1950, when Lima was struck by a tornado the refinery electrical system was not affected. Later the refinery was requested to reduce its electrical demand to compensate for a critical power shortage. However, within 8 hours after the storm, the refinery was back on the line completely.

Foundations.—Usually such items as foundations are commonplace in any construction job but we believe that the T.C.C. unit foundation at the

Cleveland No. 1 refinery is unique in many respects (Fig. 8). First, the problem of design in this case involved building a foundation upon a foundation. Second, we believe that a near record was established in the speed with which this pour was made.

Historically, the T.C.C. unit is built upon land which was a subglacial deposit. Test borings show no bedrock within many feet of the site. During the last half century, many Sohio enterprises occupied the site—dry kilns, carpenter shops, and drumming operations.

For the last major installation on this site, it was necessary to drive 480 piles averaging 18 ft. in length. Calculations showed that this pile structure was still insufficient for the new T.C.C. unit. Between the existing piles it was necessary to drive 140 additional piles, making a total of 620 piles in an area 52 by 72 ft. The new mat was started upon the existing pile caps and extended to grade. This mat was poured as a monolithic structure, being a cube 4 ft., deep by 52 ft. wide and 72 ft. long To make this pour within reasonable time involved the most intense scheduling of operations which has yet been done in Sohio construction.

Traffic between our No. 1 refinery, our Cleveland sale division, and Broadway—one of Cleveland's most heavily traveled arterial highways—had to be reckoned with. This situation was further complicated by the fact that all concrete had to be transported across the Cuyahoga River (an inland waterway used extensively by the steel mills for the delivery of iron ore). Since all bridges along this river are of the lift type, their operation was a factor to be taken into account in the pouring schedule. Despite these complications, this mass pour was completed in 8½ hours. The pour required the use of 33 trucks delivering an average load of 4 yards of concrete every 30 seconds during the 8½-hour period.

Thus we have described new or unusual problems in buildings, and operating unit construction. We propose in the remainder of this article to describe some of the considerations which have been given to accessory equipment, either for units or installations made as small individual projects. The following illustrations of these items have been chosen because they have been vital and have contributed a great deal to the ultimate objective of economical, smoothly operating equipment.

Accessory Equipment

Insulation and studies on insulation very aptly describes what we have termed "accessory equipment." On a major refining unit, insulation can and frequently does account for from 5-7 per cent of construction cost.

Coking unit.—Sohio's crude-coking unit completed within the past year in the Lima refinery presents an excellent example of what can be accomplished in the field of high-temperature insulation. Any delayed-coking unit presents a difficult problem in the insulation of the coke drums. These vessels, 17 ft. in diameter by 78 ft. long, go through a temperature change of 950° F. daily, thus imposing far more than normal demands upon insulating materials so far as expansion, temperature gradients, and disintegration are concerned. Our problem has been to design an insulating and protective covering which would give the requisite temperature protection and still be free from high maintenance cost. These rigid demands have presented an engineering challenge which Sohio has successfully met in the Lima installation.

As may be seen from Fig. 9, this type of insulating permits the following:

1. Freedom to expand and contract vertically.
2. Freedom to expand laterally.
3. Sectionalized method of installation permits ready access to any portion where repairs and maintenance are required.
4. Small units of insulation have reduced the effect of dead weight in causing disintegration of insulation.
5. The design prevents all but minimum entry of water into the equipment.

There are no data available on maintenance on these units yet, but the unit has been operating since

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March 1950 and, to date, this insulation has held up very well.

Water-treater.—Further observations on accessory equipment have indicated to us the value of properly designed and installed auxiliaries for optimum performance of major units, an excellent example of this type of equipment being the water-treating system presently employed in the Lima refinery. The problem was a method for increasing the capacity of the treated-water system without increasing the demands on boiler-house operators. This objective was accomplished by a simplified method of material handling developed by the Sohio engineer and specialist groups working in conjunction with manufacturers of chemical-handling and proportioning equipment (Fig. 10). The end result has been a system which requires only adjustment attention instead of the previous manual operations.

All chemicals are now received into the plant in economical hopper-car lots, pneumatically unloaded, and stored in a portion of a coal bunker no longer needed for its original purpose. The chemicals, lime and soda ash, feed by gravity into automatic, mechanical feeders where solution and slurry formation take place, then flow to solution tanks where proportioners regulate the flow to the softeners.

In this development, much benefit was gained from the experience of the refinery personnel and boiler-house operators. The system has proved so attractive that a study has been made at Sohio's Toledo refinery where a similar installation may be possible.

Control room.—The earlier discussions in this article stressed the developmental aspects of our newer buildings but did not include control rooms. Here as elsewhere, however, there has been further development of the graphic panel which had its beginning, we believe, in Sun Oil Co.'s Marcus Hook refinery in about 1937. Evolution of the "graphic" idea has been so rapid, however, that we believe the installation as developed for Lima refinery's solvent lube plant represents a totally different basic concept of graphic instrumentation.

The graphic panel located in the solvent lube-plant control room is arranged as a U-shaped console (Fig. 11). Before him on this panel the operator in charge has a graphic multicolored picture of all operating variables plus finger-tip control of each variable. This precise control of operations is another step in the objective of producing quality products economically.

The following economics are illustrative of the progress in instrumentation made possible by the graphic panel:

1. A $13,000 saving in the cost of the control house. The instrumentation contained in this console would normally require a 66-ft.-long control board housed in a structure at least 40 ft. square. Our control panel is approximately 28 ft. long and fits into a building 18 by 28 ft. This building cost $7,000 versus a $20,000 building cost for conventional instrumentation, hence a savings of $13,000.

2. A $5,000 saving through the use of less-expensive indicating-type instruments made possible by the graphic panel.

3. A $2,000 saving through the use of a prefabricated console shipped as a package unit from the manufacturer and installed completely assembled at the plant, requiring only air, electrical, and control tubing connections.

T.C.C. unit.—An interesting sidelight on the graphic panel has affected the T.C.C. unit at Sohio's No. 1 refinery. Where flow lines are painted on the Lima graphic panel, these lines are represented at No. 1 refinery as anodized, colored aluminum tubing fastened to the control panel. This tubing, which is readily detachable, will make the problem of modernization of these control panels much simpler than the method of painting now required.

Lube plant.—In the Lima solvent lube plant, other new uses of old ideas are seen. One of these is the fluid flow method of handling clay in the clay-contact unit. By means of a head tank (Fig. 12) a constant fluid head is maintained on the system for the introduction of clay to the mixing tank where the clay and oil are com-

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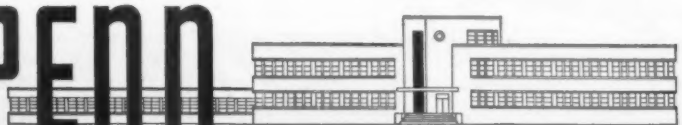

AUTOMATIC CONTROLS

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bined. This system eliminated the necessity for mechanical handling equipment with resulting high operating costs and maintenance problems which has been used in the past.

Quality control has been the watchword throughout the planning and building of the lube plant. This control has been extended to the auxiliaries, one of which is the air-conditioning system designed and installed on the finished-stock tankage (Fig. 13). In effect, this system resembles the dehumidifiers which are currently becoming popular for domestic use except that it has been expanded many times and designed for continuous service.

Atmospheric air is passed through a drier and forced into the finished lube stock, additive, and blending tanks by a system of spiral welded piping duct work so that a positive pressure of 1 to 1½ oz. is maintained within each tank. The individual tanks are fitted with seal vents and each air supply manifold is equipped with a safety valve set for 1¾ in. of water. This protection system effectively eliminates the possibility of increasing the pressure in the system to a point which would lift the tank roofs.

No doubt, readers are aware of the use of coin-operated gas pumps in some states. Sohio has a similar device for loading black-oil trucks. This device, about to go into use at the No. 1 refinery, illustrates an entirely new trend in the business of loading, computing gallonage, and dispatching oils at terminal points. The redesigned No. 1 refinery loading rack is equipped with key-actuated metering equipment (Fig. 14). Each driver who enters the rack for loading has a key which simultaneously starts the loading pump metering equipment, automatically totals the gallonage delivered, and identifies the driver receiving the load, all by means of a charted record. Since this heavy-oil handling is an around-the-clock operation, the entire procedure is speeded up by the drivers procuring their loads independently.

Taking the "Greek" Out of Blueprints

(Continued from page 230)

ess improvement, and labor studies can use models to advantage. These men normally spend much time away from their desks studying physical layout of equipment. A large part of this time can be saved by consulting a model instead of the real plant. Because it shows relationship of all equipment and permits an over-all view of the plant obtainable no other way, plant models stimulate creative thinking.

Safety

Those responsible for safety can use models to distinct advantage. They can quickly check the design of a proposed plant for various hazards, location of escape ladders, and safety equipment in general. In the case of an existing plant, a model may be used to detect potential safety hazards and to plan fire control, since it shows the physical relationship of all buildings and operating machinery to exits and fire equipment. It may be used also for safety-indoctrination lectures and to facilitate discussion of past accidents.

Savings

Experience indicates that models of complex plants, if fully utilized, can decrease the cost of design, construction, and startup. Since these savings are in terms of man hours, it follows that the plant will be on stream earlier, unless there are delays such as procurement of equipment and materials. Lower operating costs will result if the model is instrumental in improving design quality, or accuracy of labor standards, or the safety record.

The model can be used in series by designers, construction forces, operating and maintenance men, and other groups, before and after plant startup. Savings credited to the model will vary with the number of groups who use it and with the complexity of the object it depicts. Sometimes the cost is shared by two or more groups. It is not possible to predict in advance

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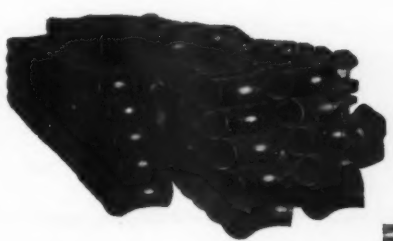

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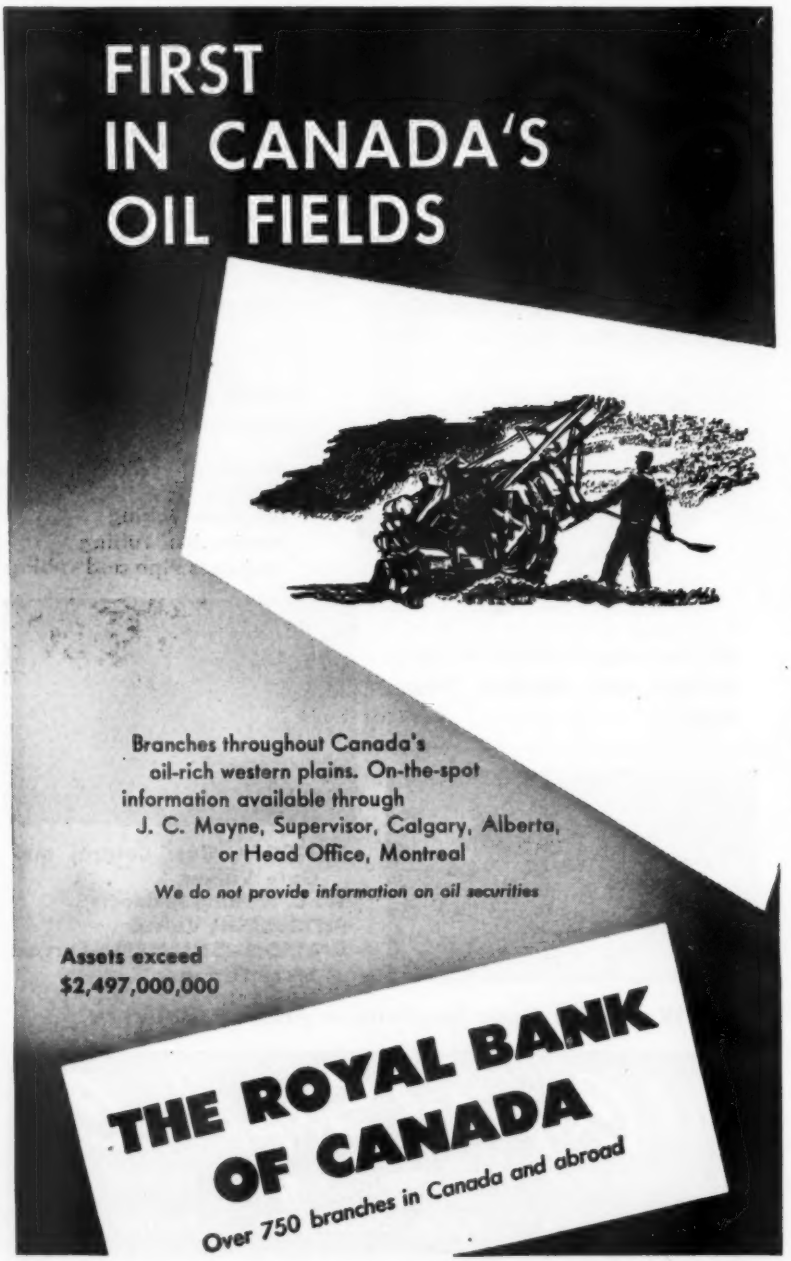
what total savings can be expected. Approximate savings are indicated by experience.

Models should not be regarded as a substitute for drawings except for arrangement studies. A test case is now under way to determine to what extent a model can substitute for construction piping drawings. No attempt is made to show vessel interiors, only the exterior features of the plant or unit. The type of model described here cannot be used to prove stress or to determine expansion allowances. Models are moderately fragile and must be handled carefully. They are, however, shipped across the country and abroad, and they can be cut up into convenient sizes for handling.

Model accuracy is about ±0.02 in. in a ¼-in. to the foot scale. This would be ±1 in. in the full-scale plant. Greater accuracy can be obtained by using a larger scale but at greater cost.

Cost

For high-spot estimating, a ¼-in. scale model will cost roughly 0.1 per cent of the plant investment. For example, a $1,000,000 installation can be modeled for about $1,000, including piping. This will vary with scale and detail. A model this size can be built in about 2 weeks and the piping installed in about another 2 weeks, or 4 weeks total after equipment arrangement and structures are established.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Sun's New Houdriflow Unit

(Continued from page 234)

unit, the heavy gas oil from the vacuum unit, the cracked light fuel produced in the existing fixed-bed unit, plus internal recycle as desired to load the unit or meet product demands.

4. A stabilization and gas-recovery unit—integrating the existing facilities and insuring high recovery of a C_4 cut for polymerization, vapor-pressure requirements and sales, and a C_3 L.P.G. for sale.

Fig. 1 shows the simplified flow diagram of the crude, vacuum, and catalytic cracking sections.

General Design of Catalytic Cracking Section

Design of the catalytic section was influenced by the following:

1. The charging-stock boiling range required the use of a moving-catalyst process, since a large part of the stock would be charged as liquid.

2. A fairly high catalyst-to-oil ratio was desirable from a viewpoint of heat balance of the unit and simplified design of the regeneration system.

3. To allow for seasonal variation in the demand of products, a wide range of conversions was desirable, and the charging capacity was to include a substantial amount of recycle stock.

Table 1 shows the characteristics of the catalytic charging stock.

The ultimate design of the cracking unit called for a reactor charge as follows:

Charge—	Bbl. per stream day
Virgin gas oil	8,480
Vacuum gas oil (from crude unit)	5,650
Vacuum gas oil (from fixed-bed tar separator)	3,690
Cracked gas oil (from fixed-bed unit)	5,740
Total feed	23,560
Recycle	4,440
Total	28,000

The newly developed Houdriflow process, combining the advantages of the T.C.C. units operated by Sun Oil Co. since 1944 with the improved techniques of pneumatic conveying of the catalyst and the means for handling mixed-phase oil charge, was chosen as fulfilling the requirements.

To obtain the investment and operating economy which goes with large capacity units, and at the same time avoid the usual handicap of having a large portion of the total production shut down at one time for maintenance, it was decided to divide the catalytic section into four complete Houdriflow units. Each of these units was to have a nominal charging ca-

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pacity of 7,000 bbl. per stream day and to be equipped with individual furnaces, but with a common fractionating tower to handle the effluent from the reactors. At this capacity the reactors and kilns could be built in shop fabricated "package" units, shipped to the site and erected with a minimum of field labor.

Maintenance of the catalytic units can be accomplished one unit at a time, with the combined capacity of three onstream units allowing practically the normal fresh feed throughput of the plant. Important savings in tankage resulted from this arrangement; also a smaller maintenance force is required.

TABLE 3—TYPICAL HOUDRIFLOW CHARGE AND YIELDS
(Two units on clay, two units on bead catalyst, gasoline 89-90 F_1 clear)

Charge—		Bbl. per stream day
Virgin gas oil		6,538
Vacuum tower gas oil		8,691
Cracked gas oil		4,530
Total feed to reactors		19,759
Internal recycle		1,268
Total charge to reactors		21,027
Products—	**Bbl.**	**Feed Vol. %**
Debutanized gasoline (90 F_1 octane, 385 at 90)	8,374	42.38
Catalytic gas oil	7,278	36.83
Hy. cracked fuel	1,370	6.93
Butane	2,383	12.06
Propane	1,498	7.58
Dry gas F.O.E.	460	2.33
Total		108.11
Coke, per cent wt. of feed		4

Houdriflow Unit Design Features

The cracking plant was designed for wide flexibility beyond the basic requirements. Both process and mechanical design were prepared with latitude for variations in charging stock, in cracking severity, in use of either natural clay or synthetic bead catalyst, and in charging sweet or high-sulfur stocks.

Because of the importance of unsaturates in the C_4 fraction at Toledo, the basic design contemplated circulating clay catalyst, with the base value of kiln and blower size set at 3,250 lb. per hour of catalyst deposit per kiln. For operation with bead catalyst, design was established to as the feed is preheated only to approximately 750° F.

Pilot-plant runs on the proposed charging stock gave basic data by which space rate requirements were established. For the design of catalyst-to-oil weight ratio of 3.8, the design space rate was set at 1.0 lb. of catalyst accommodate coke deposit at 3,000 lb. per hour.

Table 2 shows the designed overall heat balance based on circulating 170 tons per hour of clay catalyst and 225 tons per hour of bead catalyst in one unit.

These catalyst rates are predicated on a kiln outlet temperature limitation of 1,000° F., the catalyst lift equipment being made of carbon steel.

The furnace duties reflect the use of a fairly high catalyst-to-oil ratio, alyst in reactor bed per 3.7 lb. oil charge per hour.

The reactor design was established to give the full range of cracking and operating flexibility. Desired cracking severity can be adjusted readily by altering catalyst circulat-

TABLE 4—PLANT SURVEY ON ONE REACTOR
(Operation on 30 A.I. clay catalyst at 870° reactor average temperature)

Charge—	Bbl. per stream day
Virgin gas oil	1,970
Vacuum tower gas oil	2,830
Cracked gas oil	1,560
Total feed to reactor	6,360
Internal recycle	940
Total charge to reactor	7,300

Products—	Bbl. per stream day	Feed, Vol %
Debutanized gasoline (385° at 90 per cent)	2,790	43.9
Catalytic gas oil	3,020	47.4
C_4 cut (total)	580	9.1
C_3 cut	300	4.7
C_2 and lighter		*1.33
Coke	†3,330	*4.0
10.5 R.v.p. gasoline	3,040	47.8
Research octane (clear)	87.5	
Motor octane (clear)	79.3	

*Weight per cent. †Pounds per hour.

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ing rate. With this additional process adjustment there was no need to make space rate a routine operating variable.

Corrosion-resistant alloy steel was specified for the oil-vapor disengaging elements, and as a liner for the shell and internal head at the bed portion of the reactors.

General Arrangement

The catalytic cracking unit is similar in arrangement to units previously described.*

The mixed-feed nozzle is of a simple design suitable for wide variation of charge-stock boiling range. Providing board control of a nominal amount of the process steam makes the nozzle readily adjustable for charging stocks all the way from total vapor to upwards of 60 per cent liquid at furnace outlet conditions, insuring at all times a satisfactory lateral temperature distribution in the reactor. No intermediate tar-separator flashing of the vapor phase from the liquid phase of the feed is necessary.

The kiln comprises two burning zones, the air being admitted near the center and flue gas taken out at the top and bottom. The amount of air circulated through each zone is regulated by pressure-differential valves. Part of the flue gas from the top of the kiln is used for operation of the catalyst lift.

Experimental Operating Period

Because the design of the Toledo Houdriflow unit differed radically from established catalytic cracking practice, it was expected that changes would have to be made in the original design to obtain optimum operating conditions. This was particularly true of some of the control instrumentation and in the design of the catalyst handling equipment.

Although the lift design was developed from pilot-plant and semi-plant-scale tests, several factors affect the efficiency and operation of the lift such as catalyst concentration and velocity, and the physical size and design of lift equipment. The influence of these factors—together with the catalyst type and characteristics—upon the attrition rate of the catalyst, made considerable experimentation with the commercial plant desirable.

To obtain comparative data on clay and synthetic bead catalyst in the Houdriflow units, particularly with respect to gas-lift performance and attrition, two units were loaded with clay and two with beads for the initial operation. The multiple reactor design made possible study of the two catalysts and investigation of different lift designs under identical plant operating conditions of charge stocks, temperatures, and oil and catalyst rates. The improvements in operating efficiency which were ac-

*The Oil and Gas Journal, January 13, 1949.

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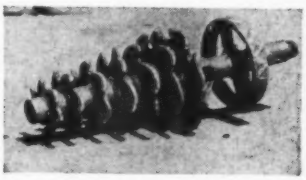

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complished by this means were of great value, and could not have been achieved except at great expense over a much longer period of time had the multiple feature of reactor design not been provided.

Four outstanding control features, developed particularly for the Toledo Houdriflow unit, are largely responsible for its successful operation. They are the catalyst flow control; gamma-ray absorption for the determination of catalyst level; pneumatic interlock system to safeguard the units against pressure fluctuations; and a system of temperature monitoring.

Regulation of the lift operating conditions by means of control-board instrumentation is the sole control on catalyst circulation rate. No flow controlling valves are required in main catalyst lines between vessels.

Catalyst level in the lift disengager is determined by measuring the gamma radiation through the catalyst bed. The catalyst inventory in the system is continuously recorded, while an alarm circuit warns of any upset in catalyst flow indicated by a sudden change in disengager catalyst level.

The pneumatic pressure interlock system protects the plant against sudden upset in operating conditions. In this system, interaction between 20 three-way air valves operated by pressure at various points bypasses the oil feed to the reactor affected, stops catalyst circulation, and remains locked in that position until an operator restores conditions to normal limits and assumes remote manual operating of the oil bypass valves. The bypass valve is an air-turbine-operated 6-in. gate valve, with a full travel time of 10 seconds. The valve will assume any desired position in its travel within 0.003 in.

Temperature monitoring includes selection of some 500 separate temperatures by means of a telephone-type dial system, any of which may be recorded if desired. A scanning system continuously inspects tube wall temperature in six furnaces, and sounds an alarm when any one of 160 points exceeds the allowable operating temperature. Another scanning system permits simultaneous and continuous indication of catalyst temperatures in the kilns and reactors.

Operating Results

The original catalyst-lift installation utilized a single 19-in. i.d. lift pipe for each unit. Considerable development work on the catalyst engagers, disengagers, and lift pipes was accomplished on a full commercial scale. Notable in this experimental period was the development of a satisfactory design of a multiple-lift system, comprising seven 8-in. diameter lift pipes operating in parallel between common catalyst engaging and disengaging vessels to effect the desired circulation rate in a single unit.

The Toledo refinery is presently operating two units equipped with the multiple lifts, while the other two units have the single 19-in. lift pipes. For catalyst circulation rates of about 200 tons per hour per unit, experience with different catalysts in the different lift systems has given the following results:

Type of catalyst	No. of lift pipes	Lift pipe i.d. (in.)	Attrition rate, tons per day
Clay	7	8	2.5
Clay	1	19	5.0
Beads	1	19	3.5

Since bead catalyst costs approximately double the cost of clay catalyst, an attrition rate of at least 1.5 tons per day must be realized on beads, compared to 2.5 tons per day on clay, to make bead and clay catalysts equal in catalyst cost at Toledo. The primary difference between clay and synthetic catalyst occurs in the composition of the gas produced.

Natural clay catalyst at Toledo produces about 45 per cent unsaturates in C_4 gas, 70 per cent in C_3 gas; synthetic bead catalyst gives C_4 gas cut of 37 per cent unsaturates, C_3 gas of 65 per cent unsaturates. Thus, clay catalyst is favored where polymerization is the principal use of the excess C_4 cut, while bead catalyst may be preferable for plants having alkylation equipment.

Table 3 shows a typical day's yield on the Houdriflow units. The data are from a day in Mid-January 1951.

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when the crude unit was producing No. 1 fuel oil thus reducing the virgin light gas oil to the catalytic unit, and catalytic conversion was limited also by high seasonal demand for distillate fuels. Four reactors were operating, two on natural clay and two on synthetic catalyst, producing gasoline of 89-90 research clear octane number.

The production of catalytic gasoline of higher octane number, up to 93-94 clear research, has been achieved but does not fit in the present over-all octane requirement, product distribution, and butane balance of the refinery.

Also, individual units have been operated to the design limit of oil-charge and coke-burning capacity. Table 4 shows an individual survey of throughput and yields on a single reactor.

Radio Truck Control

(Continued from page 238)

Communication is not limited to the relatively narrow confines of the refinery proper. Under normal conditions clear reception on both the transmitter station and mobile units is possible up to 30 miles, the longest distance yet attempted. It is indicated that under favorable conditions a maximum range is far beyond this distance.

Atmospheric conditions seem to have little effect on traffic. Blind spots are limited to tunnels and areas under bridges and railroad trestles. Control modulation in the equipment results in almost complete elimination of extraneous noises. In fact it is the opinion of the operators that reception is much clearer and less distorted than over the telephone system.

Tide Water engineers plan to extend radio dispatching to the control of fork-lift trucks in a new packaging and shipping building now under construction. Preliminary tests with the portable walkie-talkie units indicate the application to be practical. A great many of the advantages arising from the present yard system will apparently result in the fork-lift truck application.

In general summary, it may be said that all anticipated objectives of the installation have been achieved. Primarily work-load of the truck operators has been reduced. Dispatching, previously achieved by written, telephoned, or word-of-mouth order, or by messenger, was a burden.

Here the new radio system gives instant equivalent coverage and, far more important, can immediately relieve emergency requirements, or cancel and change previous assignments to meet current requirements. Other departments are afforded transportation and truck or crane service without delay. Usage of valuable mechanized equipment is greatly increased.

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341 Refineries Now Operating, 39 Idle, Survey Reveals

Total crude-oil capacity exceeds 7,000,000 bbl. per day. Texas still leads, and California in second place

EXPLANATION OF ABBREVIATIONS USED IN TABLES

Refinery type:
- (S)—Crude-oil distillation
- (A)—Asphalt
- (L)—Lubricating oils
- (C)—Catalytic cracking, thermal cracking, vis-breaking, reforming, etc.
- (W)—Wax
- (Comp.)—Complete refinery with S-C-L plus A and/or W.

Catalytic cracking unit type:
- (F)—Fluid
- (T)—Thermofor
- (H)—Houdry
- (Hf)—Houdriflow
- (Pf)—Platforming
- (C)—Cycloversion
- (S)—Suspensoid

Summary of Refineries in the United States

THEIR DISTRIBUTION AND CAPACITY*

	Operating plants				Idle plants			All plants		
	No. plants	Crude-oil cap.	Thermal cracking cap.†	Catalytic cracking cap.	No. plants	Crude-oil cap.	Cracking cap.	No. plants	Crude-oil cap.	Cracking cap.‡
Alabama	2	9,000	.....	.....	..	.....	.....	2	9,000	.....
Arkansas	6	64,500	17,300	21,150	1	2,500	.....	7	67,000	38,450
California	50	1,074,900	453,200	185,500	6	26,500	19,500	56	1,101,400	658,200
Colorado	6	23,900	7,300	3,000	..	.....	.....	6	23,900	10,300
Delaware	1	3,500	.....	.....	..	.....	.....	1	3,500	.....
Georgia	1	5,500	.....	.....	..	.....	.....	1	5,500	.....
Idaho	1	3,500	600	.....	..	.....	.....	1	3,500	600
Illinois	16	441,500	156,100	135,400	3	12,000	3,800	19	453,500	295,300
Indiana	9	372,800	115,200	112,000	..	.....	.....	9	372,800	227,200
Kansas	15	229,750	104,840	47,000	1	1,000	1,000	16	230,750	152,840
Kentucky	7	79,000	37,300	21,500	..	.....	.....	7	79,000	58,800
Louisiana	14	505,200	108,300	195,640	1	5,000	.....	15	510,200	303,940
Maryland	3	67,500	13,000	27,000	..	.....	.....	3	67,500	40,000
Massachusetts	2	47,000	15,000	.....	..	.....	.....	2	47,000	15,000
Michigan	16	119,450	25,100	26,750	1	3,500	1,500	17	122,950	53,350
Minnesota	2	7,500	.....	.....	..	.....	.....	2	7,500	.....
Mississippi	2	8,500	2,000	.....	..	.....	.....	2	8,500	2,000
Missouri	1	38,200	18,500	20,000	..	.....	.....	1	38,200	38,500
Montana	11	60,500	15,000	18,300	8	6,300	.....	19	66,800	33,300
Nebraska	4	10,400	800	.....	2	1,100	.....	6	11,500	800
New Jersey	7	435,000	89,600	168,000	..	.....	.....	7	435,000	257,600
New Mexico	8	16,950	6,650	6,000	..	.....	.....	8	16,950	12,650
New York	6	92,500	19,500	18,000	..	.....	.....	6	92,500	37,500
Ohio	12	299,100	174,000	115,500	..	.....	.....	12	299,100	289,500
Oklahoma	21	304,000	117,700	85,050	1	2,000	.....	22	306,000	202,750
Oregon	1	3,500	.....	.....	..	.....	.....	1	3,500	.....
Pennsylvania	17	512,900	137,720	175,295	..	.....	.....	17	512,900	313,015
Rhode Island	3	13,000	1,400	.....	..	.....	.....	3	13,000	1,400
South Carolina	1	7,500	.....	.....	..	.....	.....	1	7,500	.....
South Dakota	2	330	.....	.....	1	100	.....	3	430	.....
Tennessee	2	5,200	1,200	.....	..	.....	.....	2	5,200	1,200
Texas	65	1,986,550	653,620	454,000	10	23,750	.....	75	2,010,300	1,107,620
Utah	5	59,450	8,300	25,300	..	.....	.....	5	59,450	33,600
Washington	2	8,500	1,000	.....	..	.....	.....	2	8,500	1,000
West Virginia	4	15,000	7,750	.....	..	.....	.....	4	15,000	7,750
Wisconsin	2	5,500	1,000	.....	..	.....	.....	2	5,500	1,000
Wyoming	14	95,260	25,650	27,100	4	9,300	1,500	18	104,560	54,250
Total	341	7,032,340	2,334,630	1,887,485	39	93,050	27,300	380	7,125,390	4,249,415

*Capacities in barrels per day. †Includes thermal cracking, vis-breaking, reforming, and various coking processes. ‡Includes all thermal and catalytic operations.

NORTH AMERICAN OPERATING REFINERIES

Where they are, their capacities, and types of processes

Compiled by The Oil and Gas Journal Statistical Department

ALABAMA

Company, refinery location, and type—	Crude-oil charge—cap. bbl. per day	Thermal cracking—cap. bbl. per day	Catalytic cracking—cap. bbl. per day and type
American Bitumuls Co.:			
Mobile (Blakely) (S-A)	6,000		
Hunt Oil Co.:			
Tuscaloosa (S-A)	3,000		
Total	9,000	None	None

ARKANSAS

Berry Asphalt Co.:			
Stephens (S-A)	1,500		
Waterloo (S-L-A)	1,000		
Henry H. Cross Co.:			
Smackover (S-L-A)	6,000		
Lion Oil Co.:			
El Dorado (Comp.)	22,000		T [1]6,000
MacMillan Petroleum Co.:			
Norphlet (S-L)	4,000		
Pan-Am Southern Corp.:			
El Dorado (S-C)	30,000	[2]17,300	F [2]15,150
Total	64,500	17,300	21,150

1. Polymer production capacity 400 bbl. daily.
2. Includes 9,300 bbl. daily delayed coking capacity.
3. Includes 7,150 bbl. daily capacity under construction. Alkylate production capacity 1,475 bbl. daily; polymer production capacity 450 bbl. daily.

CALIFORNIA

Aromalene, Inc.:			
Long Beach (S)	1,800		
Bell Petroleum Co.:			
Casmalia (S-C)	3,500	200	
Ben Hur Refining Corp.:			
Long Beach (S)	4,700		
Calstate Refining Co.:			
Long Beach (C)		2,000	
Caminol Co., Ltd.:			
Hanford (S-C)	5,800	2,400	
Century Oil Co.:			
Signal Hill (S)	5,000		
Douglas Oil Co. of California:			
Bakersfield (S-C)	6,500	[4]4,600	
Paramount (S-A)	4,000		
Edgington Oil Refinery:			
Long Beach (S-L-A)	5,000		
Envoy Petroleum Co.:			
Long Beach (S-A)	3,000		
Five C Refining Co.:			
Santa Maria (S-A)	3,500		
Fletcher Oil Co.:			
Wilmington (C)		[5]3,600	
General Petroleum Corp.:			
Lebec (S)	23,000		
Torrance (S-C)	125,000	[6]43,500	T 40,000
Vernon (S-A)	4,000		
Golden Bear Oil Co.:			
Oildale (S-L-A)	3,000		
Hancock Oil Co. of California:			
Long Beach (S-C)	12,500	[7]7,000	
MacMillan Petroleum Corp.:			
Signal Hill (S)	7,000		
McCallen Refining Co.:			
Huntington Beach (S)	5,500		
Mohawk Petroleum Corp.:			
Bakersfield (S-C)	11,500	[8]3,500	
Newhall Refining Co.:			
Newhall (S-A)	3,000		
Norwalk Co.:			
Maricopa (S)	[9]10,000		
Bakersfield (S-C)	5,000	3,000	
Olympic Refining Co.:			
Long Beach (S)	5,500		
Oxnard Oil & Refining Co.:			
Oxnard (S-A)	2,500		
Palomar Oil & Refining Corp.:			
Bakersfield (S-L-A)	1,800		
Paraffin Companies, Inc.:			
Emeryville (S-A)	1,500		

CALIFORNIA (Continued)

Company, refinery location, and type—	Crude-oil charge—cap. bbl. per day	Thermal cracking—cap. bbl. per day	Catalytic cracking—cap. bbl. per day and type
Petrol Corp.:			
Los Angeles (S-A)	6,000		
Richfield Oil Corp.:			
Watson (S-C)	100,000	[7]45,000	T 23,000
Rothschild Oil Co.:			
Santa Fe Springs (S-C-A)	13,000	5,000	
Seaside Oil Co.:			
Ventura (S-A)	4,000		
Shell Oil Co.:			
Martinez (Comp.)	45,000	26,000	
Wilmington (S-C)	52,000	[8]31,000	F 20,000
Socal Oil & Refining Co.:			
Huntington Beach (S-C)	2,000	1,600	
Standard Oil Co. of California:			
Bakersfield (S-C)	17,000	8,000	
El Segundo (S-C)	117,000	[9]69,000	
Richmond (Comp.)	138,000	[10]56,000	T 32,500
Sunland Refining Corp.:			
Bakersfield (S)	3,000		
Sunray Oil Corp.:			
Santa Maria (S-A)	7,500	3,000	
Sunset Oil Co.:			
Los Angeles (S)	[11]13,000	[12]3,500	
Texas Co.:			
Los Angeles (S-C)	55,000	[13]10,000	F 20,000
Tide Water Associated Oil Co.:			
Associated (Comp.)	[14]85,000	[15]34,100	F 22,500
Wilmington (C)		[16]3,200	
Triangle Oil & Refining Co.:			
Venice (S)	2,500		
Union Oil Co. of California:			
Bakersfield (S-A)	5,800		
Oleum (Comp.)	[17]29,000	[18]42,000	
Wilmington (S-C-A)	[19]69,000	[20]31,000	T 27,500
Western Asphalt & Refining Co.:			
Wilmington (S-A)	1,500		
Westoil Terminals Co.:			
Wilmington (S)	24,000		
Wilshire Oil Co., Inc.:			
Norwalk (S-C)	22,000	[21]10,000	
Total	1,074,900	453,200	185,500

1. Includes 1,000 bbl. of daily capacity under construction.
2. Polymer production capacity 50 bbl. daily.
3. Includes 16,000 bbl. daily vis-breaking capacity; 5,000 bbl. daily reforming capacity and 22,500 bbl. daily coking capacity. Refinery is equipped with alkylation and polymerization facilities.
4. Includes 4,000 bbl. daily of shutdown capacity.
5. Capacity on fresh feed basis; cracking 2,000 bbl. and vis-breaking 5,000 bbl. daily.
6. Includes 5,000 bbl. daily capacity shut down.
7. Butane isomerization capacity 900 bbl. daily. Alkylate production capacity 4,000 bbl. daily. Propylene polymerization production capacity 350 bbl. daily.
8. Alkylate production capacity 5,000 bbl. daily.
9. Alkylate production capacity 4,250 bbl. daily.
10. Alkylate production capacity 2,700 bbl. daily.
11. Includes shutdown capacity of 3,000 bbl. daily.
12. Under construction.
13. Alkylate production capacity 3,800 bbl. daily.
14. Includes crude oil charged to vis-breaking and feed-preparation units.
15. Includes vis-breaking operations. Refinery equipped with alkylation and polymerization facilities.
16. Vis-breaking operation.
17. Includes 3,000 bbl. of daily capacity under construction.
18. Includes coking, 18,600 bbl. daily and crude-oil cracking 23,400 bbl. daily.
19. Crude-oil capacity is divided, 59,000 bbl. daily to combination unit and 10,000 bbl. daily to topping unit.
20. Refinery equipped with alkylation facilities. Production capacity of gas reversion operations 5,700 bbl. daily.
21. Polymerization unit (production capacity 600 bbl. daily) under construction. Alkylation unit, 2,000 bbl. daily production capacity not operating.

COLORADO

Bay Petroleum Corp.:			
Denver (S-C)	6,000	[1]2,000	
Continental Oil Co.:			
Denver (S-C)	8,300	1,800	T [2]3,000

COLORADO (Continued)

Company, refinery location, and type—	Crude-oil charge—cap. bbl. per day	Thermal cracking—cap. bbl. per day	Catalytic cracking—cap. bbl. per day and type
Empire Petroleum Co.:			
Denver (S-A)	2,000	.....	.....
Oriental Refining Co.:			
Alamosa (S-C)	1,100	900	.....
Denver (S-C)	5,000	2,000	.....
Skelly Oil Co.:			
Denver (S-C)	1,500	600	.....
Total	23,900	7,300	3,000

1. Polymer production capacity 60 bbl. daily.
2. Fresh-feed basis. Polymer production capacity 375 bbl. daily.

DELAWARE

Texas Co.:			
Claymont (S-A)	3,500	.....	.....

GEORGIA

Mexican Pet. Corp. of Georgia:			
Savannah (S-A)	5,500	.....	.....

IDAHO

Phillips Petroleum Co.:			
Pocatello (S-C)	3,500	[1]600	.....

1. Gasoline production capacity.

ILLINOIS

Advance Refining Co.:			
Centralia (S)	2,300	.....	.....
Ashland Oil & Refining Co.:			
St. Elmo (S-C)	5,000	2,500	.....
Calumet Refining Co.:			
Burnham (S-L)	1,200	.....	.....
Cross Co., Henry H.:			
Colmar (S)	1,000	.....	.....
Dupo Refining Co., Inc.:			
Dupo (S)	1,000	.....	.....
Globe Oil & Refining Co.:			
Lemont (S-C-A)	37,000	[1]21,500	F 6,000
Ohio Oil Co.:			
Robinson (S-C-A)	[2]40,000	[3]9,000	F 12,400
Pana Refining Co. Div. of Illinois Farm Supply Co.:			
Pana (C-S)	4,000	[4]1,900	.....
Petco Corp.:			
Blue Island (S-C)	20,000	[5]7,000	7,500
Red River Refining Co.:			
Chicago (S-L)	1,100	.....	.....
Shell Oil Co.:			
Wood River (Comp.)	120,000	[6]31,000	F 38,000
Sinclair Refining Co.:			
Hartford (S-C-A)	28,000	[10]13,000	F 10,000
Socony-Vacuum Oil Co., Inc.:			
East St. Louis (S-C)	30,000	13,200	H;T 18,000
Standard Oil Co. (Ind.):			
Wood River (Comp.)	43,900	[7]17,000	F 13,500
Texas Co.:			
Lawrenceville (Comp.)	[8]47,000	[9]15,000	F 30,000
Lockport (S-C-A)	60,000	25,000	.....
Total	441,500	156,100	135,400

1. Includes 6,500 bbl. daily reforming capacity. Polymer production capacity 900 bbl. daily.
2. Includes 15 bbl. daily of shutdown capacity.
3. Polymer production capacity 1,000 bbl. daily.
4. Polymer production capacity 75 bbl. daily under construction.
5. Polymer production capacity 350 bbl. daily. Thermal operations include 2,000 bbl. daily vis-breaking capacity.
6. Includes 2,500 bbl. daily reforming capacity and 7,900 bbl. daily vis-breaking capacity. Alkylate production capacity 1,500 bbl. daily.
7. Includes reforming capacity. Alkylate production capacity 1,600 bbl. daily. Polymer production capacity 50 bbl. daily.
8. Capacity rating for last half of 1951.
9. Includes 5,000 bbl. daily of reforming capacity. Polymer production capacity 2,000 bbl. daily.
10. Includes 6,000 bbl. daily reforming capacity. Polymer production capacity 600 bbl. daily.

INDIANA

Cities Service Oil Co. (Del.):			
East Chicago (S-C)	35,000	[1]20,000	F 14,700
Indiana Farm Bureau Co-op Assn., Inc.:			
Mount Vernon (S-C)	10,000	[2]3,600	F 3,300
Johnson Oil Supply Corp.:			
Gary (S)	2,500	.....	.....

INDIANA (Continued)

Company, refinery location, and type—	Crude-oil charge—cap. bbl. per day	Thermal cracking—cap. bbl. per day	Catalytic cracking—cap. bbl. per day and type
R. J. Oil & Refining Co., Inc.:			
Princeton (S)	[3]6,500	[4]1,500	.....
Rock Island Refining Corp.:			
Zionsville (S-C)	10,000	.....	F [5]5,000
Sinclair Refining Co.:			
East Chicago (Comp.)	90,000	[6]32,000	F 30,000
Socony-Vacuum Oil Co., Inc.:			
East Chicago (S-C)	25,000	[7]9,500	H 9,000
Standard Oil Co. (Ind.):			
Whiting (Comp.)	192,000	[8]48,600	F 50,000
Troy Refining Co.:			
Troy (S)	1,800	.....	.....
Total	372,800	115,200	112,000

1. Includes delayed coking capacity 17,500 bbl. daily and 2,500 bbl. daily reforming capacity. Alkylate production capacity 1,900 bbl. daily.
2. Polymer production capacity 300 bbl. daily.
3. Includes 4,000 bbl. daily capacity under construction.
4. Under construction.
5. Polymer production capacity 300 bbl. daily.
6. Includes 8,000 bbl. daily reforming capacity. Alkylate production capacity 750 bbl. daily. Polymer production capacity 2,450 bbl. daily.
7. Includes 2,700 bbl. daily polyforming capacity.
8. Includes 5,000 bbl. daily reforming capacity and 8,500 bbl. daily hydroformer charge capacity. Alkylate production capacity 4,000 bbl. daily. Polymer production capacity 1,500 bbl. daily.

KANSAS

Bareco Oil Co.:			
Wichita (S-C)	7,000	[1]7,200	.....
Bay Petroleum Corp.:			
McPherson (S-C)	6,000	[2]3,500	.....
Cooperative Refinery Assn.:			
Coffeyville (Comp.)	20,000	[3]4,500	F 5,000
Phillipsburg (S-C)	4,000	[4]2,000	.....
Derby Oil Co.:			
Wichita (S-C-A)	10,000	[5]4,000	F [6]7,500
El Dorado Refining Co.:			
El Dorado (S-C)	10,000	[7]6,000	.....
Kanotex Refining Co.:			
Arkansas City (S-C-A)	9,000	[8]8,800	.....
Missouri Farmers Association:			
Chanute (S-C)	1,850	1,100	.....
National Co-op Refinery Assn.:			
McPherson (S-C)	[9]23,000	[10]11,500	F [11]10,000
Phillips Oil Co.:			
Kansas City (Comp.)	58,000	[12]14,000	(F)
Shallow Water Refining Co.:			
Garden City (S-C-A)	2,500	[13]5,000	.....
Skelly Oil Co.:			
El Dorado (S-C-A)	35,000	[14]17,000	F 14,500
Socony-Vacuum Oil Co., Inc.:			
Augusta (S-C-A)	27,000	[15]8,940	H 10,000
Standard Oil Co. (Ind.):			
Neodesha (S-C)	10,400	[16]7,100	.....
Vickers Petroleum Co., Inc.:			
Potwin (S-C)	6,000	[17]4,200	.....
Total	229,750	104,840	47,000

1. Includes 4,000 bbl. daily reforming capacity. Polymer production capacity 150 bbl. daily.
2. Polymer production capacity 75 bbl. daily.
3. Polymer production capacity 800 bbl. daily.
4. Polymer production capacity 800 bbl. daily.
5. Polymer production capacity 100 bbl. daily.
6. Under construction.
7. Includes 1,000 bbl. daily reforming capacity. Polymer production capacity 100 bbl. daily.
8. Includes 4,500 bbl. daily catalytic reforming capacity. Polymer production capacity 300 bbl. daily.
9. Includes 3,000 bbl. daily capacity under construction.
10. Includes 1,500 bbl. daily thermal reforming capacity and 3,000 bbl. daily nonoperating catalytic reforming capacity. Polymer production capacity 1,000 bbl. daily with operation of catalytic cracking unit.
11. Under construction.
12. Production including thermal and catalytic operations. Refinery is equipped with alkylation and polymerization facilities.
13. Polymerization unit, 100 bbl. daily production capacity, under construction.
14. Includes 5,000 bbl. daily reforming capacity. Polymer production capacity 1,000 bbl. daily. Alkylation production capacity 700 bbl. daily.
15. Includes 1,440 bbl. daily reforming capacity and 3,600 bbl. daily vis-breaking capacity. Alkylate production capacity 700 bbl. daily.
16. Includes 2,000 bbl. daily reforming capacity.
17. Includes 1,000 bbl. daily reforming and 3,200 bbl. daily vis-breaking capacity. Polymer production capacity 135 bbl. daily.

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KENTUCKY

Company, refinery location, and type—	Crude-oil charge—cap. bbl. per day	Thermal cracking—cap. bbl. per day	Catalytic cracking—cap. bbl. per day and type
Aetna Oil Co.:			
Louisville (S-C)	10,000	6,000	
Ashland Oil & Refining Co.:			
Catlettsburg (1) (S-C-A-)	18,000	[3]9,500	
Catlettsburg (2) (S-C)	25,000	.....	T [2]18,500
Louisville Refining Co.:			
Louisville (S-C)	6,000	[5]3,300	F [4]3,000
Somerset Refinery:			
Somerset (S)	1,500	.....	
Standard Oil Co. (Ohio):			
Latonia (S-C-A)	16,500	[5]18,500	
Stoll Oil Refining Co.:			
Louisville (S-L-W)	2,000	.....	
Total	79,000	37,300	21,500

1. Includes 2,500 bbl. daily reforming capacity.
2. Polymer production capacity 1,200 bbl. daily. Refinery equipped with alkylation facilities.
3. Includes 800 bbl. daily reforming capacity. Polymer production capacity 30 bbl. daily.
4. Under construction.
5. Includes 5,000 bbl. daily reforming capacity. Polymer production capacity 400 bbl. daily.

LOUISIANA

Bayou State Oil Corp.:			
Hosston (S-L-A)	1,000		
Bay Petroleum Corp., The:			
Chalmette (S-C)	12,000	[1]7,000	F [2]5,640
Calumet Refining Co.:			
Princeton (S-L-A)	700		
Canal Refining Co.:			
Church Point (S)	1,000		
Cit-Con Oil Corp.:			
Lake Charles (L-W)	([3])		
Cities Service Refining Corp.:			
Lake Charles (S-C)	150,000	12,000	F 85,000
Continental Oil Co.:			
Lake Charles (S-C)	11,000	[4]5,500	
Esso Standard Oil Co.:			
Baton Rouge (Comp.)	245,000	[5]50,000	F 105,000
Evangeline Refining Co., Inc.:			
Jennings (S-C)	1,000	400	
Gilcrease Oil Co.:			
Meraux (S)	4,000		
Pan-Am Southern Corp.:			
Destrehan (S-L-A)	15,000		
Petco Corp.:			
Marrero (S-C)	7,500	[6]4,500	
Shell Oil Co.:			
Norco (S-C-L)	50,000	[7]24,500	
Stanolind Oil & Gas Co.:			
Vivian (Superior) (S-C)	[8]7,000	[8]4,400	
Total	505,200	108,300	195,640

1. Polymer production capacity 200 bbl. daily.
2. Under construction.
3. Processes stocks from outside sources to produce lubes and wax. Plant charging capacity 6,000 bbl. daily.
4. Includes 1,500 bbl. daily thermal reforming capacity. Alkylate production capacity 765 bbl. daily. Polymer production capacity 600 bbl. daily.
5. Includes reforming and vis-breaking capacity. Alkylate production capacity 10,000 bbl. daily. Polymer production capacity 4,000 bbl. daily.
6. Includes vis-breaking capacity. Polymer production capacity 400 bbl. daily under construction.
7. Includes reforming capacity. Alkylate production capacity 1,020 bbl. daily. Polymer production capacity 600 bbl daily.
8. Includes 1,500 bbl. daily capacity shut down.
9. Includes 1,200 bbl. daily reforming capacity under construction. Polymer production capacity 190 bbl. daily.

MARYLAND

American Bitumuls Co.:			
Baltimore (S-A)	6,000	.....	
Esso Standard Oil Co.:			
Baltimore (Comp.)	55,000	[1]13,000	27,000
Pan American Refining Corp.:			
Baltimore (S-A)	6,500	.....	.....
Total	67,500	13,000	27,000

1. Includes reforming and vis-breaking capacity. Alkylate production capacity 3,500 bbl. daily.

MASSACHUSETTS

Cities Service Oil Co. (Pa.):			
East Braintree (S-A)	15,000		

MASSACHUSETTS (Continued)

Company, refinery location, and type—	Crude-oil charge—cap. bbl. per day	Thermal cracking—cap. bbl. per day	Catalytic cracking—cap. bbl. per day and type
Esso Standard Oil Co.:			
Everett (S-C-A)	32,000	[1]15,000	
Total	47,000	15,000	None

1. Includes reforming and vis-breaking capacity. Polymer production capacity 500 bbl. daily.

MICHIGAN

Aurora Gasoline Co.:			
Detroit (S-C-A)	16,000	[9]9,000	F 7,000
Elsie (S)	5,500	.....	
Bay Refining Corp.:			
Bay City (S)	10,500		
Crystal Refining Co. of Carson City, Inc.:			
Carson City (S)	6,200		
Lakeside Refining Co.:			
Kalamazoo (S)	2,300	[3]600	
Leonard Refineries, Inc.:			
Alma (S-C-A)	10,000		T [6]6,000
Marvel Refining Co.:			
Grand Rapids (S)	2,000		
Mid-West Refineries, Inc.:			
Alma (S-C)	10,000	[1]2,600	Pf 1,750
Naph-Sol Refining Co.:			
Muskegon (S-C)	[5]5,250	[6]2,500	
Old Dutch Refining Co.:			
Muskegon (S-C)	4,500	1,200	Pf 2,000
Osceola Refining Co., Inc.:			
Reed City (S)	2,000		
Petroleum Specialties, Inc.:			
Flat Rlock (S-C)	6,500		Pf [7]1,000
Producers Refining, Inc.:			
West Branch (S-A)	3,500		
Pure Oil Co.:			
Midland (S)	4,700		
Roosevelt Oil & Refining Corp.:			
Mount Pleasant (S-C)	8,000	1,500	
Socony-Vacuum Oil Co., Inc.:			
Trenton (S-C)	22,000	[8]7,700	H 9,000
Total	119,450	25,100	26,750

1. Includes reformer and vis-breaker capacity. Polymer production capacity 1,000 bbl. daily.
2. Gasoline reforming capacity.
3. Polymer production capacity 100 bbl. daily.
4. Includes reformer capacity. Polymer production capacity 70 bbl. daily.
5. Includes 250 bbl. daily shutdown capacity.
6. Polymer production capacity 40 bbl. daily.
7. Under construction. Future capacity 1,500 bbl. daily.
8. Includes polyformer capacity.

MINNESOTA

Northwestern Refining Co.:			
New Brighton (S)	2,500		
St. Paul Park (S-A)	5,000		
Total	7,500	None	None

MISSISSIPPI

Paluxy Asphalt Co.:			
Crupp (S-C-A)	2,500	2,000	
Southland Oils, Inc.:			
Sandersville (S-A)	5,000	.....	
Total	8,500	2,000	None

MISSOURI

Standard Oil Co. (Ind.):			
Sugar Creek (S-C-W-A)	38,200	[1]18,500	F 20,000

1. Includes reforming capacity. Polymer production capacity 850 bbl. daily.

MONTANA

Big West Oil Co. of Montana:			
Kevin (S-C-A)	2,000	[1]1,500	.....
Carter Oil Co.:			
Billings (S-C-A)	20,000	.....	F 10,000
Continental Oil Co.:			
Billings (S-C)	6,800	.....	F [3]3,300
Farmers Union Central Exchange, Inc.:			
Laurel (S-C-A)	12,000	[6]6,000	F 5,000
Hart Refineries:			
Missoula (S-A)	800	.....	.....

MONTANA (Continued)

Company, refinery location, and type—	Crude-oil charge—cap. bbl. per day	Thermal cracking—cap. bbl. per day	Catalytic cracking—cap. bbl. per day and type
North Star Refining Co.:			
Shelby (S)	1,500	.....	.....
Phillips Petroleum Co. (Operator):			
Great Falls (S-C)	2,800	[4]600	.....
Solar Oil & Refining Co.:			
Hardin (S)	2,500	.....	.....
Texas Co.:			
Sunburst (S-C)	7,500	5,000	.....
Union Oil Co. of California:			
Cut Bank (S-C)	3,600	[5]1,900	.....
Unity Petroleum Corp.:			
Kalispell (S-A)	1,000	.....	.....
Total	60,500	15,000	18,300

1. Includes 300 bbl. daily reforming capacity.
2. Polymerization production 360 bbl. daily.
3. Polymerization production 150 bbl. daily.
4. Production including polymer gasoline.
5. Polymerization production 70 bbl. daily.

NEBRASKA

Cooperative Refinery Assn.:			
Scotts Bluff (S-C)	2,200	800	.....
Mid-States Refining Co.:			
Falls City (S)	6,000	.....	.....
Searle Petroleum Co.:			
Omaha (S)	1,500	.....	.....
Sioux Oil Co.:			
Chadron	700	.....	.....
Total	10,400	800	None

NEW JERSEY

California Refining Co.:			
Barber (S-C-A)	[1]50,000	[2]16,000	Hf [3]25,000
Cities Service Oil Co. (Pa.):			
Linden (S-A)	15,000	.....	.....
Pettys Island (S-A)	10,000	.....	.....
Esso Standard Oil Co.:			
Linden, Bayonne, and Jersey City (Comp.)	165,000	[4]48,000	F 65,000
Socony-Vacuum Oil Co., Inc.:			
Paulsboro (Comp.)	[5]58,000	[6]9,200	H;T 22,000
Texas Co.:			
Westville (S-C)	60,000	[7]9,000	F 30,000
Tide Water Associated Oil Co.:			
Bayonne (Comp.)	77,000	[8]7,400	H;T 26,000
Total	435,000	89,600	168,000

1. Includes 25,000 bbl. daily under construction.
2. Includes 12,000 bbl. daily reforming capacity of which 10,000 bbl. daily is under construction.
3. Under construction. Alkylation facilities, 2,500 bbl. daily under construction.
4. Includes reforming and vis-breaking capacity. Polymer production capacity 2,500 bbl. daily.
5. Includes crude oil charged directly to cracking units.
6. Includes reforming and vis-breaking capacity. Alkylate production capacity 1,500 bbl. daily.
7. Reforming capacity. Polymer production capacity 2,500 bbl. daily.
8. Includes reforming capacity and 1,500 bbl. daily shutdown cracking capacity. Polymer production capacity 2,500 bbl. daily.

NEW MEXICO

Arex Co.:			
Bloomfield (S)	200	.....	.....
Continental Oil Co.:			
Artesia (S-C)	3,400	1,450	.....
Farmington (S)	750	.....	.....
Famariss Oil & Refining Co.:			
Monument (S)	600	.....	.....
Malco Refineries, Inc.:			
Roswell (S-C)	2,500	1,000	.....
McNutt Oil & Refining Co., Inc.:			
Brickland (S-C)	3,000	[1]1,200	.....
New Mexico Asphalt & Refining Co.:			
Artesia (S-C)	5,000	2,500	T [2]6,000
Petroleum Products Refining & Prod. Co.:			
Prewitt (S-C)	1,500	500	.....
Total	16,950	5,650	6,000

1. Polymer production capacity 50 bbl. daily under construction.
2. Under construction. Polymer production capacity 300 bbl. daily under construction.

NEW YORK

Frontier Oil & Refining Co.:			
Tonawanda (S-C)	10,000	2,500	.....
Gulf Oil Corp.:			
Staten Island (S)	20,000	.....	.....
Sinclair Refining Co.:			
Wellsville (Comp.)	9,000	[1]8,000	.....
Socony-Vacuum Oil Co., Inc.:			
Brooklyn (Comp.)	[2]22,500	3,500	H 9,000
Buffalo (Comp.)	[2]24,000	5,500	H 9,000
Olean (S-L)	7,000	.....	.....
Total	92,500	19,500	18,000

1. Includes reforming capacity.
2. Includes crude oil charged to cracking unit.
3. Includes 2,000 bbl. daily shutdown capacity.

OHIO

Ashland Oil & Refining Co.:			
Canton (S-C)	12,000	3,000	.....
Dewese Oil Refinery:			
Weston (S-L-W)	500	.....	.....
Gulf Refining Co.:			
Cleves (S-C)	30,000	[1]12,300	F 12,000
Toledo (S-C)	40,000	[2]13,200	F 12,000
National Refining Co.:			
Findlay (S-C)	9,500	[3]5,800	.....
Pure Oil Co.:			
Newark (S-C)	15,500	[4]9,000	F 4,500
Toledo (S-C)	29,400	[5]19,700	.....
Standard Oil Co. (Ohio):			
Cleveland (Comp.)	42,500	[6]36,000	T 25,000
Toledo (Comp.)	21,000	[7]31,000	.....
Lima (Comp.)	36,500	[8]27,000	F 20,000
Sun Oil Co.:			
Toledo (S-C)	60,000	[9]17,000	H;Hf 42,000
Western Reserve Refining Co.:			
Niles (S)	2,200	.....	.....
Total	299,100	174,000	115,500

1. Polymer production capacity 1,500 bbl. daily.
2. Polymer production capacity 1,500 bbl. daily.
3. Includes reforming capacity.
4. Includes reforming and vis-breaking capacity. Polymer production capacity 200 bbl. daily.
5. Includes reforming and vis-breaking capacity.
6. Includes reforming capacity. Polymer production capacity 700 bbl. daily.
7. Includes reforming and coking capacity. Alkylate production capacity 1,800 bbl. daily. Polymer production capacity 500 bbl. daily.
8. Includes reforming, coking and recycle capacity. Polymer production capacity 550 bbl. daily.
9. Polymer production capacity 1,100 bbl. daily.

OKLAHOMA

Allied Materials Corp.:			
Stroud (S-A)	2,000	.....	.....
Anderson-Prichard Oil Corp.:			
Cyril (S-C)	10,000	[1]5,000	.....
Bell Oil & Gas Co.:			
Granfield (S-C)	7,000	[2]3,750	Pf 1,500
Ben Franklin Refining Co.:			
Ardmore (S-C)	7,500	[3]4,500	.....
Champlin Refining Co.:			
Enid (Comp.)	20,000	[4]12,500	.....
Cities Service Oil Co. (Del.):			
Ponca City (S-C)	13,000	4,500	F 10,000
Continental Oil Co.:			
Ponca City (Comp.)	52,500	[5]12,500	T 16,750
Deep Rock Oil Corp.:			
Cushing (Comp.)	18,000	[6]10,000	F 5,000
Johnson Oil Refining Co.:			
Cleveland (S-C)	6,000	[7]2,750	Pf [8]1,800
Kerr-McGee Oil Industries, Inc.:			
Wynnewood (S-C)	9,000	[9]3,000	.....
Mercury Oil Refining Co.:			
Oklahoma City (S-C)	5,000	1,500	.....
Mid-Continent Petroleum Corp.:			
West Tulsa (Comp.)	50,000	[10]18,000	F 16,000
Midland Cooperative Wholesale:			
Cushing (S-C)	6,500	[11]3,400	.....
Monarch Refineries, Inc.:			
Oklahoma City (S)	1,000	.....	.....
Peppers Refining Co.:			
Oklahoma City (S-C)	1,500	[12]500	.....
Phillips Oil Co.:			
Okmulgee (S-C)	8,000	[13]1,600	.....
Sunray Oil Corp.:			
Allen (S-C)	10,000	[14]8,000	.....
Duncan (S-C)	25,000	[15]5,000	F 15,000

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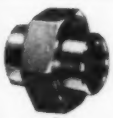

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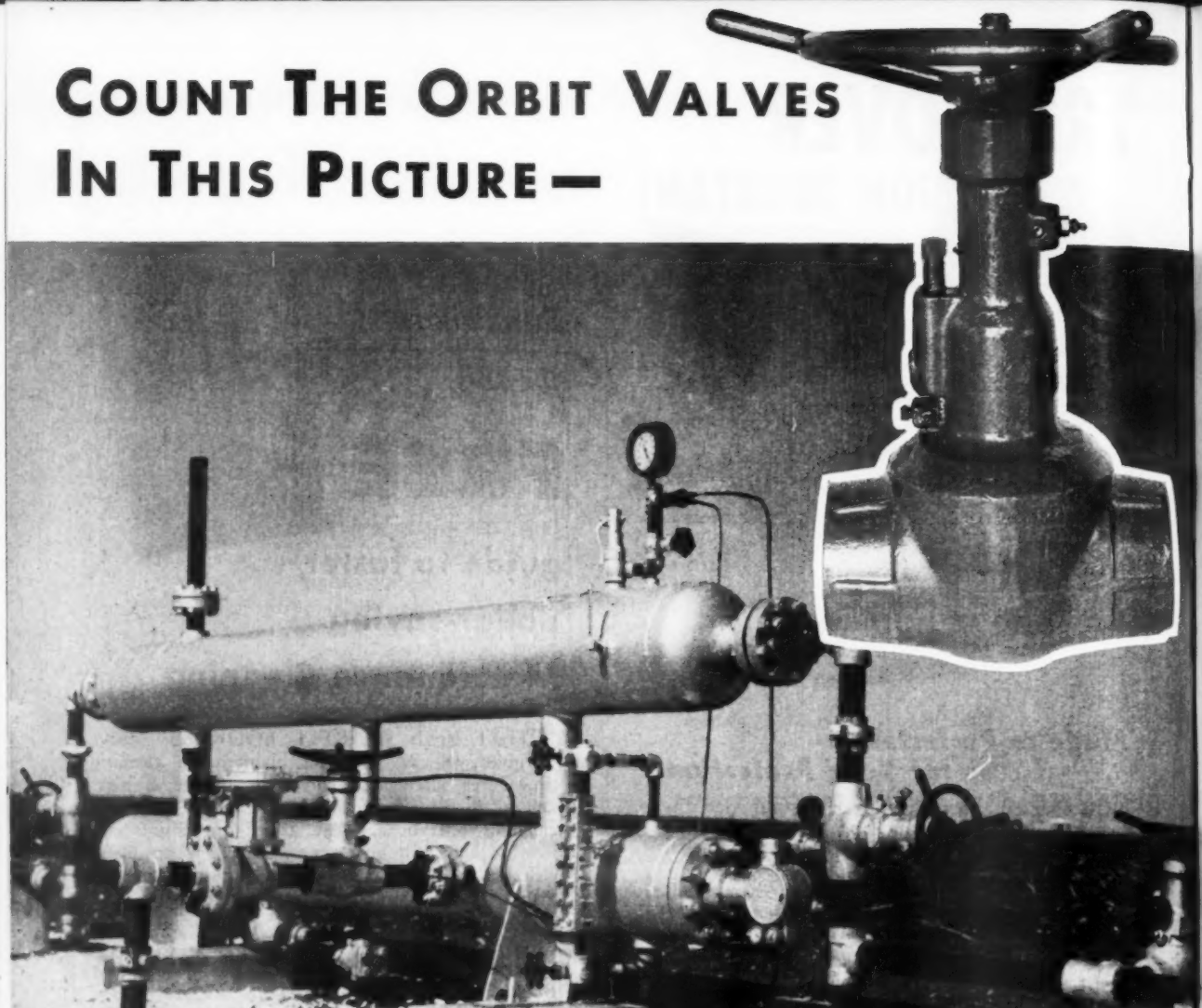

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OKLAHOMA (Continued)

Company, refinery location, and type—	Crude-oil charge—cap. bbl. per day	Thermal cracking—cap. bbl. per day	Catalytic cracking—cap. bbl. per day and type
Texas Co.:			
West Tulsa (S-C)	35,000	[16]14,000	F 15,000
Tide Water Associated Oil Co.:			
Drumright (S-C)	12,000	[17]5,000	Hf [18]4,000
Wilcox Oil Co.:			
Bristow (S-C)	5,000	2,200	.....
Total	304,000	117,700	85,050

1. Polymer production capacity 150 bbl. daily.
2. Polymer production capacity 90 bbl. daily.
3. Polymer production capacity 100 bbl. daily.
4. Includes reforming capacity.
5. Includes hydroforming capacity. Polymer production capacity 700 bbl. daily. Alkylate production capacity 3,000 bbl. daily.
6. Includes reforming and vis-breaking capacity. Polymer production capacity 350 bbl. daily.
7. Refinery equipped with polymerization facilities.
8. Under construction.
9. Vis-breaking capacity.
10. Includes reforming and vis-breaking capacity. Polymer production capacity 1,500 bbl. daily. Alkylate production capacity 850 bbl. daily.
11. Includes reforming capacity.
12. Reforming capacity.
13. Gasoline production including polymer.
14. Polymer production capacity 350 bbl. daily.
15. Vis-breaking capacity. Polymerization operations produce 1,000 bbl. daily polymer gasoline or 1,600 bbl. daily B-B stock. Former government-owned alkylation unit rated at 2,200 bbl. daily production scheduled for reactivation.
16. Includes reforming capacity. Polymer production capacity 1,800 bbl. daily.
17. Idle capacity.
18. Polymer production capacity 1,500 bbl. daily.

OREGON

Stancal Asphalt & Bitumuls Co.:			
Portland (S-A)	3,500	.....	.....
Total	3,500	None	None

PENNSYLVANIA

Atlantic Refining Co.:			
Philadelphia (Comp.)	117,000	[1]28,000	F 30,000
Cities Service Oil Co. (Pa.):			
Titusville (S-L-W)	3,000	.....	.....
Freedom-Valvoline Oil Co.:			
Freedom (Comp.)	4,000	[2]1,750	.....
Gulf Oil Corp.:			
Neville Island (Pittsburgh) (S-C)	14,000	6,000	.....
Philadelphia (S-C-L)	107,000	[3]31,200	F 25,000
Kendall Refining Co.:			
Bradford (Comp.)	5,000	[4]2,200	Pf [5]1,200
Pennsylvania Refining Co.:			
Karns City (S-L-W)	1,400	.....	.....
Pennzoil Co.:			
Rouseville (Comp.)	8,500	[6]5,850	F [6]2,825
Quaker State Oil Refining Corp.:			
Bradford (Comp.)	4,200	1,350	.....
Emlenton (Comp.)	2,000	1,350	.....
Oil City (Comp.)	2,800	1,200	[7]1,050
Sinclair Refining Co.:			
Marcus Hook (S-C)	90,000	[8]32,000	F 30,000
Sonneborn, L., Sons, Inc.:			
Franklin (S-L)	2,000	.....	.....
Petrolia (S-L-W)	4,000	.....	.....
Sun Oil Co.:			
Marcus Hook (Comp.)	140,000	[9]24,000	H 84,500
United Refining Co.:			
Warren (Comp.)	5,500	[10]2,200	.....
Wolf's Head Oil Refining Co., Inc.:			
Reno (Comp.)	2,500	[11]620	[11]720
Total	512,900	137,720	175,295

1. Includes reforming capacity. Polymer production capacity 1,900 bbl. daily. Alkylate production capacity 200 bbl. daily exclusive of aviation grade requirements.
2. Includes reforming capacity. Polymer production capacity 50 bbl. daily.
3. Alkylate production capacity 240 bbl. daily.
4. Includes reforming capacity. Polymer production capacity 100 bbl. daily.
5. Under construction.
6. Portion of jointly owned facilities. Polymer production capacity 280 bbl. daily.
7. Portion of jointly owned facilities.
8. Includes reforming capacity. Polymer production capacity 1,850 bbl. daily.
9. Reforming capacity.
10. Polymer production capacity 100 bbl. daily.
11. Portion of jointly owned facilities.

RHODE ISLAND

Company, refinery location, and type—	Crude-oil charge—cap. bbl. per day	Thermal cracking—cap. bbl. per day	Catalytic cracking—cap. bbl. per day and type
American Bitumuls Co.:			
East Providence (S-A)	1,500	.....	.....
Socony-Vacuum Oil Co., Inc.:			
East Providence (S-C-A)	8,000	[1]1,400	.....
Texas Co.:			
Providence (S)	3,500	.....	.....
Total	13,000	1,400	None

1. Idle capacity.

SOUTH CAROLINA

Esso Standard Oil Co.:			
Charleston (S-A)	7,500	.....	.....

SOUTH DAKOTA

Hot Springs Refining Co.:			
Hot Springs (S)	200	.....	.....
How Kola Refining Corp.:			
Sturgis (S)	130	.....	.....
Total	330	None	None

TENNESSEE

Delta Refining Co.:			
Memphis (S-C)	4,200	1,200	.....
Southern Oil Service:			
Nashville (S)	1,000	.....	.....
Total	5,200	1,200	None

TEXAS

American Liberty Oil Co.:			
Mount Pleasant (S-C-A)	14,000	[14]4,000	.....
Atlantic Refining Co.:			
Port Arthur (S-C)	50,000	.....	F [2]26,000
Baird Refining Co.:			
Baird (S-C)	2,500	2,750	.....
Col-Tex Refining Co.:			
Colorado City (S-C-A)	12,000	[3]4,300	.....
Consumers Co-op Refinery Association:			
Levelland (S-C)	[4]6,500	2,600	.....
Continental Oil Co.:			
Wichita Falls (S-C)	7,000	[5]4,400	.....
Cosden Petroleum Corp.:			
Big Spring (S-C-A)	17,000	7,500	F [6]7,500
Crown Central Petroleum Corp.:			
Houston (S-C-L)	26,000	[7]8,500	T 15,000
Danaho Refining Co.:			
Pettus (S-C)	[8]4,000	[9]1,200	.....
Dodds Refining Co., Inc.:			
Jacksonville (S)	1,000	.....	.....
Eastern States Petroleum Co., Inc.:			
Houston (S-C)	37,500	[10]16,000	F 10,000
Eddy Refining Co.:			
Houston (S)	2,000	.....	.....
Gladewater Refining Co.:			
Gladewater (S-C)	2,500	[11]1,500	C 100
Great Southern Corp.:			
Corpus Christi (C)	.....	4,000	.....
Gulf Oil Corp.:			
Fort Worth (S-C)	9,500	4,000	.....
Port Arthur (Comp.)	230,000	[12]84,200	H;T 34,000
Sweetwater (S-C)	8,000	4,000	.....
Humble Oil & Refining Co.:			
Baytown (Comp.)	[13]315,000	[14]78,100	[15]79,200
Inland Refining Co., Inc.:			
Palestine (S-C)	2,000	1,020	.....
Lacy, R., Inc.:			
Big Sandy (S-C-A)	3,000	1,000	.....
LaSalle Petroleum Corp.:			
Burkburnett (S)	1,500	.....	.....
Magnolia Petroleum Co.:			
Beaumont (Comp.)	150,000	[16]62,000	H;T 71,000
Fort Worth (S-C)	12,000	[17]9,300	.....
Maritime Oil Co.:			
Houston (S)	5,000	.....	.....
McBride Refining Co.:			
La Blanca (S-L-A)	2,500	.....	.....
McMurrey Refining Co.:			
Tyler (S-C)	9,000	4,500	.....
Mex-Tex Oil Co.:			
Rio Grande City (S)	200	.....	.....

TEXAS (Continued)

Company, refinery location, and type—	Crude-oil charge—cap. bbl. per day	Thermal cracking—cap. bbl. per day	Catalytic cracking—cap. bbl. per day and type
Monarch Refining Co.:			
San Antonio (S)	1,200	.....	.....
Onyx Refining Co.:			
Abilene (S-C)	[1]5,500	[19]2,900	.....
Pan American Refining Corp.:			
Texas City (S-C)	114,000	([20])	F 32,000
Panhandle Producing & Refining Co.:			
Wichita Falls (S-C)	5,800	[21]2,000	F 1,500
Patton Oil Co.:			
Rotan (S)	1,500	.....	.....
Peerless Tank Cleaning Co.:			
Kilgore (S)	1,000	.....	.....
Petroleum Products Refining & Producing Co.:			
Leuders (S-C)	1,500	500	.....
Petrolite Corp.:			
Kilgore (S-W)	700	.....	.....
Phillips Oil Co.:			
Borger (S-C)	56,000	[22]23,000	.....
Sweeny (S-C)	45,000	[23]11,000	(F)
Pontiac Refining Corp.:			
Corpus Christi (S)	20,000	.....	.....
Petrol Refining, Inc.:			
Texas City (S-C)	60,000	.....	H 11,000
Premier Petroleum Co.:			
Arp (S-C)	5,000	3,000	.....
Baird (S-C)	2,500	1,200	.....
Longview (S-C)	4,000	1,600	.....
Fort Worth (S-C)	4,500	1,600	.....
Pure Oil Co.:			
Nederland (Comp.)	55,000	[24]15,200	T 9,800
Rado Refining Co.:			
McAllen (S)	2,000	.....	.....
Republic Oil Refining Co.:			
Texas City (S-C)	38,000	[25]14,250	F 13,000
Shamrock Oil & Gas Corp.:			
Sunray (S-C)	10,000	[26]5,000	Hf [27]5,900
Shell Oil Co.:			
Deer Park (Houston) (Comp.)	115,000	[28]46,000	F 33,500
Sid Richardson Refining Co.:			
Texas City (S-C)	[29]25,000	[30]20,000	.....
Sinclair Refining Co.:			
Corpus Christi (S-C)	28,000	[31]10,000	H 12,000
Houston (Comp.)	90,000	[32]38,000	H;T 22,000
Skelly Oil Co.:			
Longview (S-C)	5,000	3,000	.....
Southwestern Oil & Refining Co.:			
Corpus Christi (S-C)	30,000	1,100	.....
Standard Oil Co. of Texas:			
El Paso (S-C)	18,000	6,000	.....
Taylor Refining Co.:			
Corpus Christi (S-C)	[33]42,500	[34]6,400	T [35]8,000
Port Isabel (S-C)	10,000	.....	Pf 4,000
Texas Co.:			
Amarillo (S-C)	8,500	[36]4,000	.....
El Paso (S-C)	5,500	3,000	.....
Port Arthur (Comp.)	190,000	[37]121,000	F 60,000
Port Neches (S-A)	40,000	.....	.....
Three Rivers Refinery:			
Three Rivers (S-L-A)	1,500	.....	.....
Tydal Co.:			
Gainesville (S)	2,000	.....	.....
Ute Oil & Refining Co.:			
Graham (S)	650	.....	.....
W. T. Waggoner Estate:			
Vernon (S-C)	5,000	2,500	.....
Wickett Refining Co.:			
Wickett (S-C)	3,000	[38]2,000	.....
Winnsboro Refining Co.:			
Winnsboro (S-C)	4 000	[39]2,500	
Total	1,986,550	653,620	454,000

1. Polymer production capacity 250 bbl. daily.
2. Polymer production capacity 450 bbl. daily.
3. Includes reforming capacity and 1,000 bbl. daily idle capacity.
4. Includes 1,500 bbl. daily shut-down capacity.
5. Includes reforming capacity. Polymer production capacity 650 bbl. daily.
6. Capacity based on 50 per cent conversion. Polymer production capacity 600 bbl. daily.
7. Includes reforming capacity.
8. Includes 1,500 bbl. daily idle capacity.
9. Includes 400 bbl. daily idle capacity. Polymer production capacity 45 bbl. daily operating 20 bbl. daily idle.
10. Includes vis-breaking capacity. Polymer production capacity 700 bbl. daily.
11. Polymer production capacity 90 bbl. daily under construction.
12. Alkylate production capacity 3,200 bbl. daily. Polymer production capacity 500 bbl. daily.
13. Includes 70,000 bbl. daily capacity under construction.
14. Includes reforming capacity and 33,000 bbl. daily idle capacity.
15. Ultimate capacity. Polymer production capacity 3,000 bbl. daily. Alkylate production capacity 7,500 bbl. daily.
16. Includes reforming and vis-breaking capacity. Alkylate production capacity 4,000 bbl. daily. Polymer production 600 bbl. daily.
17. Includes reforming capacity. Polymer production capacity 300 bbl. daily.
18. Includes 1,000 bbl. daily under construction.
19. Includes reforming capacity.
20. Thermal cracking operations are carried out in combination units having a charging capacity of approximately 114,000 bbl. daily. Alkylation production capacity 4,000 bbl. daily. Polymer production capacity 2,500 bbl. daily. Catalytic reforming capacity 6,500 bbl. daily.
21. Includes reforming capacity. Polymer production capacity 150 bbl. daily.
22. Gasoline production from thermal cracking and alkylation operations.
23. Gasoline production from thermal and catalytic cracking operations.
24. Includes reforming and vis-breaking capacity. Alkylate production capacity 2,000 bbl. daily. Polymer production capacity 800 bbl. daily.
25. Includes idle reforming capacity. Polymer production capacity 350 bbl. daily.
26. Polymer production capacity 300 bbl. daily.
27. Under construction.
28. Includes reforming capacity. Alkylate production capacity 4,000 bbl. daily.
29. Includes 15,000 bbl. daily idle capacity.
30. Total charge basis including reforming and vis-breaking.
31. Includes reforming capacity. Alkylate production capacity 1,700 bbl. daily.
32. Includes reforming capacity. Alkylate production capacity 2,400 bbl. daily.
33. Includes 20,000 bbl. daily under construction.
34. Includes reforming.
35. Under construction including 400 bbl. daily polymerization unit.
36. Polymer production capacity 150 bbl. daily.
37. Includes reforming capacity. Polymer production capacity 3,000 bbl. daily. Alkylate production capacity 12,000 bbl. daily.
38. Includes reforming, 800 bbl. daily under construction.
39. Vis-breaking capacity.

UTAH

Company, refinery location, and type—	Crude-oil charge—cap. bbl. per day	Thermal cracking—cap. bbl. per day	Catalytic cracking—cap. bbl. per day and type
Phillips Petroleum Co.:			
Woods Cross (S-C-A)	4,200	[1]800	.....
Salt Lake Refining Co.:			
North Salt Lake (S-C)	27,000	.....	Hf 13,000
Uinta Oil Refining Co.:			
Vernal (S-C)	1,250	300	.....
Utah Oil Refining Co.:			
Salt Lake City (S-C)	23,500	[2]7,200	F 12,300
Western States Refining Co.:			
North Salt Lake (S)	3,500	.....	.....
Total	59,450	8,300	25,300

1. Gasoline production capacity including polymerization operations.
2. Alkylate production capacity 3,800 bbl. daily; 2,850 bbl. daily shut down.

WASHINGTON

Phillips Petroleum Co.:			
Spokane (S-C)	5,000	[1]1,000	.....
Stancal Asphalt & Bitumuls Co.:			
Richmond Beach (Seattle) (S-A)	3,500	.....	.....
Total	8,500	1,000	None

1. Gasoline production capacity including polymerization operations.

WEST VIRGINIA

Carbide Carbon Chemicals Co.:			
Charleston (S-C)	2,500	1,200	.....
Elk Refining Co.:			
Falling Rock (Comp.)	4,500	[1]1,200	.....
Pure Oil Co.:			
Cabin Creek (Comp.)	5,500	[2]4,000	.....

WEST VIRGINIA (Continued)

Company, refinery location, and type—	Crude-oil charge—cap. bbl. per day	Thermal cracking—cap. bbl. per day	Catalytic cracking—cap. bbl. per day and type
Quaker State Oil Refining Corp.:			
St. Marys (Comp.)	2,500	1,350	.....
Total	15,000	7,750	None

1. Polymer production capacity 100 bbl. daily.
2. Polymer production capacity 110 bbl. daily.

WISCONSIN

Lake Superior Refining Co.:			
Superior (S-C)	[1]4,000	[2]1,000	.....
Wisconsin Oil Refining Co., Inc.:			
Sheboygan (S)	1,500	.....	.....
Total	5,500	1,000	None

1. Future capacity.
2. Includes reforming capacity.

WYOMING

C & H Refinery:			
Lusk (S)	160	.....	.....
Continental Oil Co.:			
Glenrock (S-C)	3,400	[1]1,800	.....
Cooperative Refinery Association:			
Newcastle (S-C)	1,800	1,000	.....
Empire State Oil Co.:			
Thermopolis (S-A)	1,500	.....	.....
Frontier Refining Co.:			
Cheyenne (S-C-A)	10,000	[2]4,500	F 3,600
Husky Refining Co.:			
Cody (S-A)	5,000	.....	.....
Ohio Oil Co.:			
Lovell (S-A)	6,000	.....	.....
Resolute Oil Corp.:			
Badger Basin (S)	1,000	.....	.....
Sinclair Refining Co.:			
Sinclair (S-C-A)	25,000	[3]8,000	F 9,000
Sioux Oil Co.:			
Newcastle (S)	2,500	.....	.....
Socony-Vacuum Oil Co., Inc.:			
Casper (S-C)	[4]8,500	.....	T [5]6,500
Standard Oil Co. (Ind.):			
Casper (Comp.)	15,900	6,350	F 8,000
Texas Co.:			
Calpet (S)	500	.....	.....
Casper (S-C-A)	14,000	[6]4,000	F 6,000
Total	95,260	25,650	27,100

1. Polymer production capacity 90 bbl. daily.
2. Polymer production capacity 300 bbl. daily.
3. Includes reforming capacity. Alkylate production capacity, 1,700 bbl. daily. Polymer production capacity, 350 bbl. daily.
4. Includes 1,500 bbl. daily idle capacity.
5. Polymer production capacity 240 bbl. daily.
6. Includes reforming capacity. Polymer production capacity, 500 bbl. daily.

Shutdown Plants in the United States

ARKANSAS

Company and refinery location—	Refinery type	Cap., bbl. per day: Crude oil	Cap., bbl. per day: Cracking
Stephens Ref. Co., Inc., Stephens	S	2,500	.....
CALIFORNIA			
Eagle Oil & Ref. Co., Santa Fe Springs	S-C-A	5,000	15,000
Economy Asphalt Co., Oxnard	S-A	2,000	.....
Harbor Ref. Co., Long Beach	S	3,000	.....
Maritime Pet. Corp., Wilmington	S	1,500	.....
Richfield Oil Corp., Vindale	S-C	10,000	4,500
Texas Co., Fillmore	S	5,000	.....
Total		26,500	19,500
ILLINOIS			
Arrow Petroleum Co., Centralia	S	4,500	1,800
Northwestern Ref. Co., St. Elmo	S-C	5,000	2,000
Sol-Tex Ref. Co., Inc., Fairfield	S	2,500	.....
Total		12,000	3,800
KANSAS			
Chanute Ref. Co., Chanute	S-C	1,000	1,000

LOUISIANA

Company and refinery location—	Refinery type	Cap., bbl. per day: Crude oil	Cap., bbl. per day: Cracking
Premier Oil Ref. Co. of Texas, Cotton Valley	S	5,000	.....
MICHIGAN			
Louis Rose Ref. Co., Saginaw	S-C	3,500	1,500
MONTANA			
Big Lake Oil Co., Lake Basin	S	100	.....
Gallatin Farmers Co., Belgrade	S	250	.....
Hole Bros. Refinery, Cut Bank	S	350	.....
Hunt, Eugene, Winnett	S	300	.....
North American O. & R. Co., Chinook	S	300	.....
Solar O. & R. Co., Soap Creek field	S	1,500	.....
Treasure State Ref. Co., Shelby	S	500	.....
Tri-Petroleum Corp., Hardin	S	3,000	.....
Total		6,300	None
NEBRASKA			
Oil Marketing & Ref., Inc., Salem	S	800	.....
Porter Oil Co., Sidney	S	300	.....
Total		1,100	None
OKLAHOMA			
Anderson-Prichard Oil Corp., Cement	S	2,000	.....
SOUTH DAKOTA			
Rex Oil Refining Co., Rapid City	S	100	.....
TEXAS			
American Mineral Spirits Co., Corpus Christi	S	12,000	.....
Bennett O. & R. Co. of Texas, Refugio	S	1,500	.....
Bryson P. L. & Ref. Co., Bryson	S	1,200	.....
Hamman O. & R. Co., Bay City	S	2,000	.....
Master Tank Co., Dallas	S	2,000	.....
Muenster Ref. Co., Muenster	S	750	.....
Owen Ref. Co., Hawley	S	1,100	.....
Reischman, R. J., Fort Stockton	S	200	.....
Rosewood O. & R. Co., Bishop	S	3,000	.....
Total		23,750	None
WYOMING			
Husky Ref. Co., Lovell	S-A	3,000	.....
Standard Oil Co. (Ind.), Greybull	S-C-A	6,000	1,500
Upton Refinery, Upton	S	100	.....
Wheatland Ref. Co., Wheatland	S	200	.....
Total		9,300	1,500

Operating Plants in Canada

Summary of Refineries in Canada — Their Distribution and Capacity*

	Operating plants: No. plants	Operating plants: Crude-oil capacity	Operating plants: Cracking capacity†
Alberta	11	67,400	28,350
British Columbia	3	28,850	5,750
Manitoba	4	19,100	6,500
New Brunswick	1	300	.....
Northwest Territory	1	1,000	.....
Nova Scotia	1	22,000	9,900
Ontario	5	107,500	60,800
Quebec	4	141,000	93,650
Saskatchewan	8	37,250	17,200
Total	38	424,400	222,150

***Barrels per day basis. †Includes reforming, vis-breaking, thermal cracking, and catalytic cracking capacities.**

ALBERTA

Company, refinery location and type—	Crude-oil charge—cap. bbl. per day	Thermal cracking—cap. bbl. per day	Catalytic cracking—cap. bbl. per day and type
British American Oil Co., Ltd.:			
Calgary (S-C-A)	7,200	2,500	.....
Edmonton (S-C)	5,200	1,400	F 3,000
Excelsior Refineries, Ltd.:			
Lloydminster (S-C-A)	[1]2,500	[2]1,900	.....
Husky Oil & Refining, Ltd.:			
Lloydminster (S-A)	7,500	.....	.....
Lloydminster (S-A)	5,000	.....	.....

ALBERTA (Continued)

Company, refinery location and type—	Crude-oil charge— cap. bbl. per day	Thermal cracking— cap. bbl. per day	Catalytic cracking— cap. bbl. per day and type
Gas and Oil Refining, Ltd.:			
Hartell (S-C)	2,500	[3]1,500	.....
Imperial Oil, Ltd.:			
Calgary (S-C-A)	10,000	[4]4,000	.....
Edmonton (S-C)	20,700	9,000	.....
McColl-Frontenac Oil Co.:			
Edmonton (S-C)	[5]5,500	[6]2,200	F 2,600
Supreme Refineries, Ltd.:			
Ogden (S-C)	1,000	250	.....
Wainwright Refineries, Ltd.:			
Wainwright (S)	300	.....	.....
Total	67,400	22,750	5,600

1. Includes 1,000 bbl. daily capacity under construction.
2. Includes vis-breaking capacity.
3. Polymer production capacity 60 bbl. daily.
4. Alkylate production capacity 950 bbl. daily.
5. New refinery under construction.
6. Delayed coking capacity. Polymer production capacity 250 bbl. daily.

BRITISH COLUMBIA

Imperial Oil, Ltd.:			
Ioco (Comp.)	12,000	2,750 [1]	.....
Shell Oil Co. of Canada, Ltd.:			
Shellburn, Vancouver (S-C-A)	8,500	[2]3,000	.....
Standard Oil Co. of British Columbia, Ltd.:			
Stanovan, Burnaby (S-L-A)	8,350	.....	.....
Total	28,850	5,750	None

1. Includes reforming capacity. Polymer production capacity 33 bbl. daily.

MANITOBA

Anglo-Canadian Oils, Ltd.:			
Brandon (S-C)	2,300	[1]1,600	.....
Imperial Oil Co., Ltd.:			
Winnipeg (East St. Paul) (S-C)	10,800	.....	F 3,100
North Star Oil, Ltd.:			
St. Boniface (S-C)	5,000	[2]1,800	.....
Radio Oil Refineries, Ltd.:			
East Kildonan (S)	1,000	.....	.....
Total	19,100	3,400	3,100

1. Includes reforming capacity.
2. Includes reforming capacity.

NEW BRUNSWICK

New Brunswick Oilfield, Ltd.:			
Weldon (S)	300	.....	.....

NORTHWEST TERRITORY

Imperial Oil, Ltd.:			
Ft. Norman (S)	1,000	.....	.....

NOVA SCOTIA

Imperial Oil, Ltd.:			
Halifax (S-C-A)	22,000	9,900	.....

ONTARIO

British American Oil Co., Ltd.:			
Clarkson (Comp.)	10,000	4,500	.....
Canadian Oil Companies, Ltd.:			
Petrolia (S-C)	[1]24,000	[2]9,800	F [3]10,000
Imperial Oil, Ltd.:			
Sarnia (Comp.)	55,500	3,000	S 23,000
McColl-Frontenac Oil Co., Ltd.:			
Toronto (S-C)	12,000	7,000	.....
Trinidad Leaseholds (Canada), Ltd.:			
Port Credit (S-C)	6,000	3,500	.....
Total	107,500	27,800	33,000

1. Includes 20,000 bbl. daily capacity under construction.
2. Includes thermal reforming, vis-breaking and catalytic reforming capacity under construction.
3. Under construction. Polymer production capacity 800 bbl. daily operating and 800 bbl. daily under construction.

QUEBEC

British American Oil Co., Ltd.:			
Montreal East (S-C-A)	32,000	[1]7,500	F 13,350
Imperial Oil, Ltd.:			
Montreal East (S-C-A)	44,000	[2]11,300	F 12,000
McColl-Frontenac Oil Co., Ltd.:			
Montreal East (S-C)	40,000	[3]17,000	F 15,000
Shell Oil Co. of Canada, Ltd.:			
Montreal East (Comp.)	25,000	[4]7,500	F 10,000
Total	141,000	43,300	50,350

1. Polymer production capacity 500 bbl. daily.
2. Includes reforming and vis-breaking capacity. Polymer production capacity 4,400 bbl. daily.
3. Includes reforming and vis-breaking capacity. Polymer production capacity 1,500 bbl. daily including 500 bbl. daily capacity under construction.
4. Includes reforming and vis-breaking capacity. Polymer production capacity 1,700 bbl. daily.

SASKATCHEWAN

Company, refinery location and type—	Crude-oil charge— cap. bbl. per day	Thermal cracking— cap. bbl. per day	Catalytic cracking— cap. bbl. per day and type
British American Oil Co., Ltd.:			
Moose Jaw (S-C-A)	6,000	2,000	.....
Hi-Way Refineries, Ltd.:			
Rosetown (S)	350	.....	.....
Saskatoon (S-C-A)	2,800	800	.....
Imperial Oil, Ltd.:			
Regina (S-C-A)	20,000	[1]12,000	.....
Moose Jaw Refineries, Ltd.:			
Moose Jaw (S)	1,500	.....	.....
Northern Petroleum Corp., Ltd.:			
Kamsack (S)	600	.....	.....
Prince Albert Refineries, Ltd.:			
Prince Albert (S)	500	.....	.....
Saskatchewan Federated Cooperative, Ltd.:			
Regina (S-C)	5,500	2,400	.....
Total	37,250	17,200	None

1. Includes reforming capacity. Polymer production capacity 750 bbl. daily.

Shutdown Plants in Canada

Company and refinery location—	Refinery type	Cap., bbl. per day: Crude oil	Cap., bbl. per day: Cracking
Home Oil Distributors, Ltd., North Vancouver	S	.....	.....
Hi-Way Refineries, Ltd., Moose Jaw, Sask.	S	350	.....
Lion Refining Co., Ltd., Calgary, Alta.	S	750	.....
Trump Oil Co., Morris, Man.	S	300	.....
Total		1,400	None

Operating Refineries in Mexico

Summary of Refineries in Mexico — Their Distribution and Capacity*

	Operating Plants: No. plants	Operating Plants: Crude-oil capacity	Operating Plants: Cracking capacity
Distrito Federal	1	39,500	11,700
Guanajuato	1	30,000	4,000
Tamaulipas	3	68,850	6,400
Veracruz	3	40,000	3,800
Total	8	178,350	25,900

***Barrels per calendar day basis.**

Company, refinery location and type—	Crude-oil charge— cap. bbl. per day	Thermal cracking— cap. bbl. per day	Catalytic cracking— cap. bbl. per day and type
Petroleos Mexicanos:			
Arbol Grande, Tamp. (S-A)	16,600	.....	.....
Atzcapotzalco, D. C. (S-C)	39,500	11,700	.....
Ciudad Madero, Tamp. (S-C-A)	47,250	6,400	.....
Mata Redonda, Ver. (S-C)	17,000	3,800	.....
Minatitlan, Ver. (S-L)	19,900	.....	.....
Poza Rica, Ver. (S)	3,100	.....	.....
Reynosa, Tamp. (S)	5,000	.....	.....
Salamanca, Gto. (S-C)*	30,000	4,000	.....
Total	178,350	25,900	None

*Lube and wax facilities planned for 1951.

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In both industry and science the name "Beckman" has become synonymous with leadership in a vital field of instrumentation—that of adapting complex scientific advancements to the quick, simple, accurate solution of modern production, analytical and control problems. If you are not using these Beckman Instruments in *your* operations, we suggest you investigate today the vital savings they can make for you...

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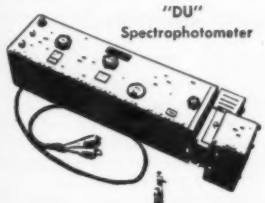

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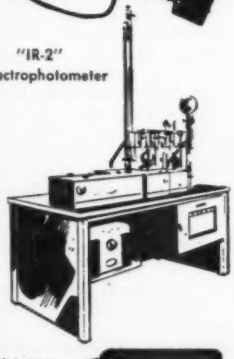

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Makes toluene determinations in minutes instead of hours—accurate to within 1% of toluene present over concentration range 0.01 to 100%. Also simplifies many other refinery applications with similar speed and accuracy.

Covers wide spectral range—near infrared, visible and ultraviolet—and entire instrument is designed for maximum accuracy, operating simplicity and compactness. Unusually rugged construction minimizes maintenance and insures sustained accuracy. Incorporates many unique design features. *Write for full details.*

BECKMAN "IR-2" INFRARED SPECTROPHOTOMETER:

Originally developed to simplify control problems in refinery operations, Beckman Infrared equipment and methods have been widely adopted by other industries as well.

The "IR-2" Spectrophotometer is the most advanced infrared equipment available and embodies far-reaching developments that greatly increase the versatility, accuracy, speed and convenience of modern infrared methods.

Analyzes hydrocarbons and other organic gases, liquids and solids by measuring absorption of infrared radiation at selected wave lengths, permitting rapid identification of each component—and its concentration—in complex mixtures. It is many times faster than other methods... is accurate to within ½ of 1% of *total* sample present... is simple to use and readily analyzes even the most complex mixtures encountered in modern refinery operations.

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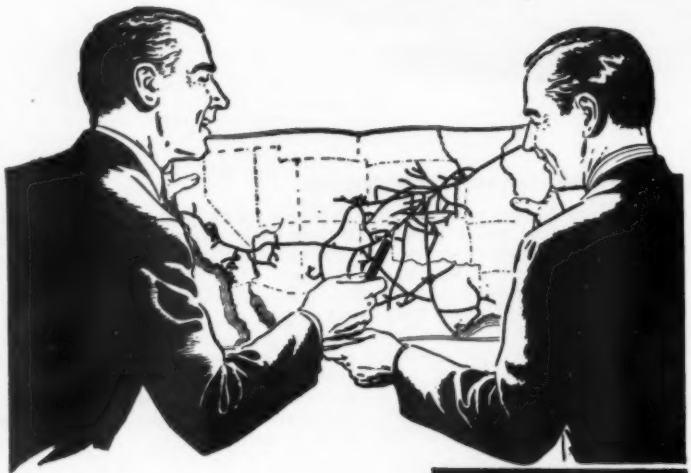

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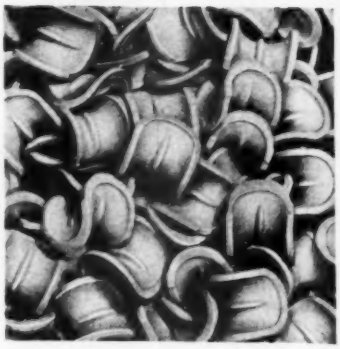

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Less Resistance

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Berl Saddles are also available in porcelain. Both the Knight-Ware and Porcelain types are dense but not glazed so as to provide better wetting. When desired, porous packings can be made of either material. Berl Saddles are available in ¼", ½", ¾", 1" and 1½" sizes. The ¼" Berl Saddles are especially suited for use in laboratory columns.

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Sharp Upward Trend in Refinery Construction

Projects involving improved-gasoline manufacture head the list

by R. B. Tuttle

THE general picture on refinery construction involving both new processes and expansion and modernization of existing equipment shows a sharp upward trend this quarter as compared to the last quarter of 1950. A number of unannounced projects, which are expected to be authorized soon, will increase activity appreciably when added to current projects.

Most of the refinery expansion and modernization projects under way in the first quarter of this year involve new processes and equipment for production of gasolines. Approximately 150,000 bbl. of daily capacity is now building for production of improved-quality gasolines by a new process. In addition to this, 20 catalytic cracking units having a total charging capacity of more than 210,000 bbl. daily are in various stages of construction. Another 50,000 bbl. of daily catalytic cracking capacity is scheduled to be constructed later this year. Five different plants ranging from 31,000 bbl. daily capacity downward represent this 50,000 bbl. of catalytic cracking capacity which is yet to be built.

Fifteen different projects are now under way for increasing the crude-oil-distillation capacity in as many refineries throughout the United States and Canada. Total capacity involved in all of these projects is more than 150,000 bbl. daily. In Canada two new refineries now being built total 25,500 bbl. daily crude-oil-input capacity. Another project in the United States not under way at this time involves plant crude-oil capacity increases of 11,000 bbl. daily.

More than 15 major expansion and modernization projects are still in the planning stage in the United States. These projects include a wide variety of new, complete processing units from a 31,000-bbl.-daily catalytic cracking unit on through to gas-concentration plants. A number of new distillation units, both atmospheric and vacuum, are also included in the list of projects planned to start later this year.

Active Refinery-Building Projects

Company, location, and type of project—	Capacity rating	Status	Comp. schedule	Contractors
Ashland Oil & Refining Co., Buffalo:				
Plant expansion	.....	Planned	.....	.....
Ashland Oil & Refining Co., Canton, Ohio:				
Expand cat. poly unit	.....	Planned	.....	.....
Aurora Gasoline Co., Detroit:				
Platforming unit, bbl. per day	4,500	Building	Early '51	Universal Oil Products Co.
Bay Petroleum Corp., Chalmette, La.:				
Expand crude-oil capacity, bbl. per day	16,000	Building	1951	Universal Oil Products Co., Procon, Inc.
Cat. cracker, bbl. per day	5,640	Building	1951	Universal Oil Products Co., Procon, Inc.
Bell Oil & Gas Co., Granfield, Okla.:				
Platforming unit, bbl. per day	1,500	Building	.....	Universal Oil Products Co.
Cracking furnace for three-coil cracking operation	.....	Planned	.....	.....
Ben Franklin Refining Co., Ardmore, Okla.:				
Expand crude-oil capacity, bbl. per day	4,500	Building	.....	.....
Expand thermal cracker, bbl. per day	1,000	Building	.....	.....
British American Oil Co., Ltd., Moose Jaw, Sask., Canada:				
Refinery expansion, bbl. per day	10,000	Building	Late '51	Process Engineers, Inc.
Cat. cracker, cat. poly and coking units	.....	Building	Late '51	Process Engineers, Inc.
Gas-concentration plant and storage facilities	.....	Building	Late '51	Process Engineers, Inc.
California Refining Co., Barber, N. J.:				
Cat. cracker, bbl. per day	25,000	Building	Early '51	Houdry Process Corp.; C. F. Braun
Reformer, bbl. per day	10,000	Building	Early '51	C. F. Braun
Alkylation unit, bbl. per day	2,500	Building	Early '51	M. W. Kellogg Co.
Crude-oil units, bbl. per day	25,000	Building	Early '51	C. F. Braun
Gasoline treater, bbl. per day	20,000	Building	Early '51	Catalytic Construction Co.
Boiler plant, lb. per hour	300,000	Building	Early '51	C. F. Braun
Calumet Refining Co., Burnham, Ill.:				
New office building	.....	Building	Early '51	Bachman & Bertram
Caminol Co., Hanford, Calif.:				
Expand crude-oil capacity, bbl. per day	1,000	Building	.....	.....
Canadian Oil Refineries, Ltd., Sarnia, Ont., Canada:				
New refinery	.....	Building	Early '52	Stone & Webster Engr. Corp.
Atmospheric and vacuum dist. units, bbl. per day	20,000	Building	Early '52	E. B. Badger & Sons Co.
Cat. cracking, gas processing, and cat. poly units, bbl. per day	8-10,000	Building	Early '52	M. W. Kellogg Co.
Cat. reforming unit, bbl. per day	3,800	Building	Early '52	.....
Storage, bbl.	1,600,000	Building	Early '52	Horton Steel Co.
Wharf and offsite facilities	.....	Building	Early '52	.....
Vis-breaking unit, bbl. per day	3,000	Building	Early '52	.....
Cat. poly unit, bbl. per day	800	Building	Early '52	.....
Champlin Refining Co., Enid, Okla.:				
Heptane bright-stock stripper, bbl. per day	12,000	Building	Early '51	Champlin
Cities Service Oil Co., Ponca City, Okla.:				
Cat. cracker, bbl. per day	10,000	Contracted	Early '52	M. W. Kellogg Co.
Cities Service Oil Co. (Pa.), Linden, N. J.:				
Vacuum unit	.....	Planned	1951	.....
Rebuild entire dock	.....	Planned	1951	.....
Col-Tex Refining Co., Colorado City, Tex.:				
Poly unit, bbl. per day	75	Building	.....	.....
Continental Oil Co., Lake Charles, La.:				
Modernize and enlarge refinery, bbl. per day	11,700	Building	Early '52	E. B. Badger & Sons Co.
Cat. cracker (T.C.C.), bbl. per day	7,000	Building	Early '52	E. B. Badger & Sons Co.
Polyforming unit, bbl. per day	2,500	Building	.....	.....
Alkylation (sulfuric) unit, bbl. per day	835	Building	.....	.....

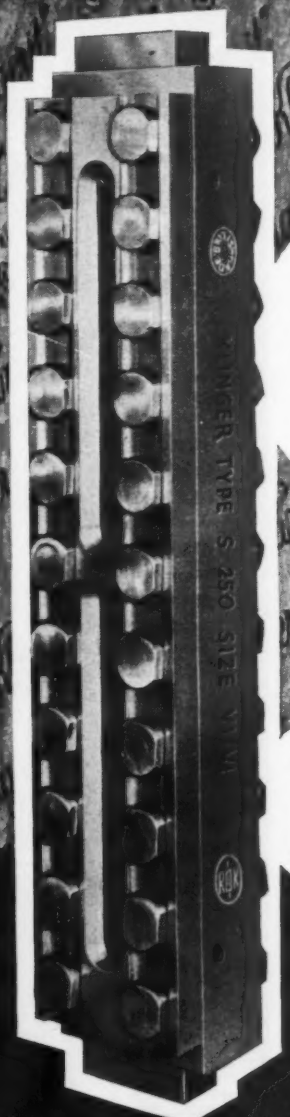
Active Refinery-Building Projects (Continued)

Company, location, and type of project—	Capacity rating	Status	Comp. schedule	Contractors
Cosden Petroleum Corp., Big Spring, Tex.:				
Crude-oil storage, bbl.	240,000	Building	Early '51	Steel Tank Constr.
Deep Rock Oil Corp., Cushing, Okla.:				
Lubricating-oil expansion, bbl. per day	150	Building	.....	.....
Derby Oil Co., Wichita, Kans.:				
Cat. cracker, bbl. per day	7,500	Building	Mid '51	Fluor Corp., Ltd.
Poly unit	.....	Building	Mid '51	Universal Oil Products Co.; Fluor Corp., Ltd.
Gas-recovery plant	.....	Building	Mid '51	Fluor Corp., Ltd.
Douglas Oil Co. of California, Paramount, Calif.:				
Thermal cracking expansion, bbl. per day	1,000	Building	.....	.....
Envoy Petroleum Co., Long Beach, Calif.:				
Oxidizing unit, bbl. per day	500	Building	.....	.....
Esso Standard Oil Co., Bayway, N. J.:				
Desalting units, bbl. per day	100,000	Building	1951	Fluor Corp., Ltd.
Esso Standard Oil Co., Everett, Mass.:				
Cat. cracking unit, bbl. per day	16,000	Planned	.....	.....
Esso Standard Oil Co, Baton Rouge, La.:				
Cat. cracking unit, bbl. per day	31,000	Planned	.....	.....
Crude distillation, bbl. per day	11,000	Planned	.....	.....
Excelsior Refineries, Ltd., Lloydminster, Alta., Canada:				
Vacuum unit, bbl. per day	1,500	Building	Early '51	Koch Engineering Co.
Famriss Oil & Refining Co., Hobbs, N. M.:				
Capacity increase, bbl. per day	600	Building	Early '51	Refinery Engineering Co
Farmers Union Central Exchange, Inc., Laurel, Mont.:				
Boiler plant	.....	Building	Early '51	.....
Cat. cracker, bbl. per day	5,000	Building	1951	.....
Cat. poly unit	150	Building	1951	.....
Fletcher Oil Co., Wilmington, Calif.:				
Capacity increase, bbl. per day	5,000	Building	Early '52	Fletcher Oil Co.
Thermal cracking expansion, bbl. per day	1,400	Building	.....	.....
Poly unit expansion. bbl. per day	25	Building	.....	.....
General Petroleum Corp., Los Angeles, Calif.:				
Cat. poly unit, bbl. per day	500	Building	Early '51	Fluor Corp., Ltd.
Gladewater Refining Co., Gladewater, Tex.:				
Poly unit, bbl. per day	90	Building	.....	.....
Gulf Oil Corp., Port Arthur, Tex.:				
Cat. cracker, bbl. per day	60,000	Building		M. W. Kellogg Co.
Hart Refineries, Missoula, Mont.:				
Plant modernization	.....	Building	.....	.....
Storage capacity	.....	Planned	.....	.....
Humble Oil & Refining Co., Baytown, Tex.:				
Crude-oil expansion, bbl. per day	70,000	Building	.....	.....
Cat. cracking expansion, bbl. per day	7,400	Building	.....	.....
Husky Oil & Refining, Ltd., Lloydminster, Alta., Canada:				
Desalting unit	.....	Building	Mid '51	Husky Oil & Refining Co.
Enlarge boiler plant	.....	Building	Mid '51	Husky Oil & Refining Co.
Additional tankage	.....	Building	Mid '51	Husky Oil & Refining Co.
Imperial Oil, Ltd., Edmonton, Alta., Canada:				
Cat. cracking unit, bbl. per day	9,000	Planned	Early '52	.....
Vacuum unit	.....	Planned	.....	.....
Inland Refining Co., Inc., Palestine, Tex.:				
Treating unit, bbl. per day	800	Contracted	.....	Grebe & Doremus
Johnson Oil Refining Co., Cleveland, Okla.:				
Platforming unit, bbl. per day	1,840	Building	Early '51	Procon, Inc.; Universal Oil Products Co.
Kendall Refining Co., Bradford, Pa.:				
Platforming unit, bbl. per day	1,500	Building	Early '51	Procon, Inc.; Universal Oil Products Co.
Lake Superior Refining Co., Superior, Wis.:				
Reerect refinery, bbl. per day	5,000	Building	1951	Refinery Engineering Co.
Louisville Refining Co., Louisville:				
Cat. cracker, bbl. per day	3,000	Building	Mid '51	Universal Oil Products Co.; Petroleum Piping Co.
Magnolia Petroleum Co., Beaumont, Tex.:				
Convert cat. cracker	.....	Building	Mid '51	.....
McColl-Frontenac Oil Co., Ltd., Edmonton, Alta., Canada:				
New refinery	.....	Building	Mid '51	Foster Wheeler Corp.; Burns & Dutton
Cat. cracker, bbl. per day	2,600	Building	Mid '51	.....
Distillation unit, bbl. per day	5,500	Building	Mid '51	.....
Delayed coker, bbl. per day	2,200	Building	Mid '51	.....
Poly unit, bbl. per day	250	Building	Mid '51	.....
McColl-Frontenac Oil Co., Ltd., Montreal, Que., Canada:				
Poly unit expansion, bbl. per day	500	Building	.....	.....
McMurrey Refining Co., Tyler, Tex.:				
Plant expansion	.....	Building	1951	Refinery Engineering Co.
McNutt Oil & Refining Co., Inc., Brickland, N. M.:				
Poly unit, bbl. per day	50	Building	.....	.....
Mid-West Refineries, Inc., Alma, Mich.:				
Platforming unit, bbl. per day	1,750	Building	Mid '51	Universal Oil Products Co.; Procon, Inc.
Monarch Refining Co., San Antonio:				
Final stabilizer	.....	Planned	.....	.....
National Cooperative Refinery Assn., McPherson, Kans.:				
Cat. cracker, bbl. per day	10,000	Building	.....	Refinery Engineering Co.
Cat. poly unit, bbl. per day	600	Building	.....	Refinery Engineering Co.
Increase crude unit, bbl. per day	3,000	Building	.....	Refinery Engineering Co.
Revamp vacuum unit, bbl. per day	10,650	Building	.....	Refinery Engineering Co.
Revamp thermal cracker, bbl. per day	2,940	Building	.....	Refinery Engineering Co.

XUM

Klinger LIQUID LEVEL Gages

FOR THE OIL INDUSTRY

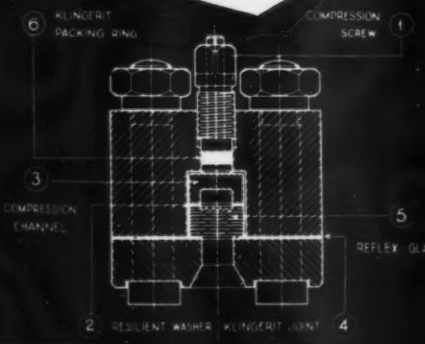


Klinger S250, Size VI/VI, Reflex Level Gage for working pressures up to 4,000 p.s.i. (250 atmospheres).

The Klinger S. Type series, of high pressure Liquid Level Gages, is specially designed for modern chemical processes in oil refining and derivant producing plant, and is made in the following standard range for the indicated working pressures :

S.120 (2,000 *p.s.i.*)	S.250 (4,000 *p.s.i.*)
S.300 (5,000 *p.s.i.*)	S.400 (6,000 *p.s.i.*)

These are so constructed that the glass is not subjected to high mechanically applied stresses in order to make a tight joint. Tightness of the joint is provided by the internal fluid pressure, so that the glass is evenly loaded and free to adjust itself in the gage body to inequalities of expansion.



The compression screw (1) provides initial pressure only between the reflex glass (5) and the "Klingerit" joint (4), via the compression channel (3) and the resilient washer (2). The actual sealing pressure on joint (4) at high pressures is given by the internal fluid pressure on the rear of the reflex glass (5). Leakage past the compression screw (1) is prevented by the "Klingerit" packing ring (6).

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For further information write for Bulletin CEC-1801-X25

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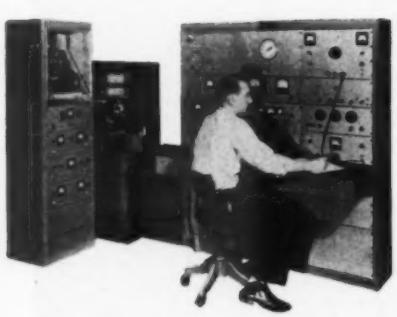

New Model 21-103 MASS SPECTROMETER is an improved successor to the instrument so extensively used by every major refiner. Now, more than ever, can plant operations be aided by the precise, rapid analyses of complex mixtures of gases and liquids obtainable only with this versatile analytical tool.

Control or exploratory analyses for:

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Substituted Organic Compounds

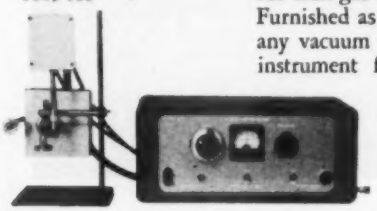
For further information write for Bulletin CEC-1800-X29

PRECISELY MEASURE GAS PRESSURES IN THE MICRON RANGE

Model 23-105 Consolidated Micromanometer accurately measures gas pressure in the 0-150 micron range *without knowledge of the composition of the gas.* The pressure readings are independent of the fact that gas might be air, a condensable vapor, or an unknown mixture. Pressure changes as small as 0.1 microns can be detected. Because of this, special calibration charts for each gas are eliminated.

Furnished as a complete unit ready for installation in any vacuum system, the micromanometer is an ideal instrument for measuring static pressures in high vacuum stills and crystallizers; or measuring the pressure of gases of unknown or variable composition.

For further information write for Bulletin CEC-1819-X6



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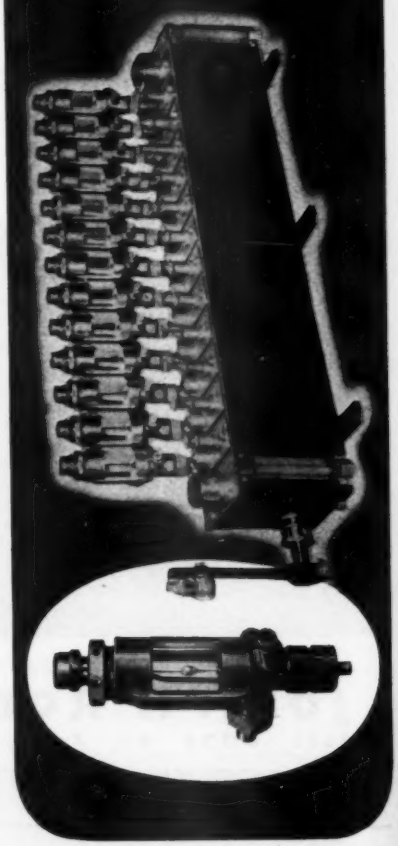

Active Refinery-Building Projects (Continued)

Company, location, and type of project—	Capacity rating	Status	Comp. schedule	Contractors
New Mexico Asphalt & Refining Co., Artesia, N. M.:				
Cat. cracker, bbl. per day	6,000	Building	1951	Southwestern Engineering Co.
Cat. poly unit, bbl. per day	300	Building	1951	Southwestern Engineering Co.
Onyx Refining Co., Abilene, Tex.:				
Revamp topping unit, bbl. per day	5,500	Building	Late '51	Onyx Refining Co.
Revamp cracking unit, bbl. per day	4,300	Building	Early '51	.....
Revamp stabilizer	.....	Building	Late '51	.....
Platforming unit, bbl. per day	900	Building	Late '51	Universal Oil Products Co.; Procon, Inc.
Crude-oil expansion, bbl. per day	1,000	Building	.....	.....
Poly unit, bbl. per day	100	Building	.....	.....
Pacific Refineries, Ltd., Hawaii:				
New refinery, bbl. per day	3,000	Building	1951	Fish Engineering Co.
Pan-Am Southern Corp., El Dorado, Ark.:				
Cat. cracker, bbl. per day	7,150	Building	Early '51	Foster Wheeler Corp.
Gas-recovery unit	.....	Building	Early '51	.....
Panhandle Production & Refining Co., Wichita Falls, Tex.:				
Increase crude-oil capacity, bbl. per day	8,000	Planned	.....	.....
Pana Refining Co., Pana, Ill.:				
Topping-unit heater, bbl. per day	6,000	Building	Early '51	.....
Poly unit, bbl. per day	75	Building	.....	.....
Peppers Refining Co., Oklahoma City.:				
Cat. poly unit, bbl. per day	1,100	Building	Early '51	Koch Engineering Co.
Petroleum Specialties, Inc., Flat Rock, Mich.:				
Platforming unit, bbl. per day	900-1,000	Building	.....	.....
Additional tankage	150,000	Building	.....	.....
Phillips Oil Co., Phillips, Tex.:				
Cat. cracker, bbl. per day	30,000	Building	Mid '51	C. F. Braun Co.
Premier Petroleum Co., Fort Worth:				
Platforming unit, bbl. per day	1,500	Building	Mid '51	Universal Oil Products Co.; Premier Petroleum Co.
R. J. Oil & Refining Co., Inc., Princeton, Ind.:				
Crude-oil expansion, bbl. per day	4,000	Building	.....	.....
Cat. cracker, bbl. per day	1,500	Planned	.....	.....
Roosevelt Oil & Refining Co., Mount Pleasant, Mich.:				
Desulfurization unit, bbl. per day	3,000	Building	Mid '51	Roosevelt Oil & Refining Co.
Salt Lake Refining Co., Salt Lake City:				
Vacuum unit, bbl. per day	9,500	Building	.....	Bechtel Corp.
Saskatchewan Federated Co-operatives, Ltd., Regina, Sask.:				
Crude-oil expansion, bbl. per day	3,500	Building	1951	.....
Thermal cracking expansion, bbl. per day	1,500	Building	1951	.....
Shallow Water Refining Co., Garden City, Kans.:				
Poly unit, bbl. per day	100	Building	Early '51	Koch Engineering Co.
Shamrock Oil & Gas Corp., Sunray, Tex.:				
Cat. cracker, bbl. per day	5,900	Building	Early '51	Catalytic Construction Co.
Feed-preparation unit, bbl. per day	10,000	Building	Early '51	Shamrock Oil & Refining Corp.
Sulfur-recovery unit, tons daily	35	Building	Early '51	Fluor Corp., Ltd.
Shell Chemical Co., Deer Park, Tex.:				
Plant modernization	.....	Building	1951	Fluor Corp., Ltd.
Shell Oil Co. of Canada, Ltd., Montreal East, Que., Canada:				
Offsite facilities	.....	Building	Early '51	Fluor Corp., Ltd.
Shell Oil Co., Houston:				
Platforming unit, bbl. per day	15,000	Building	1951	Universal Oil Products Co.; Procon, Inc.
Shell Oil Co., Wood River, Ill.:				
Platforming unit, bbl. per day	15,000	Building	1951	Universal Oil Products Co.; Procon, Inc.
Sid Richardson Refining Co., Texas City, Tex.:				
Thermal cracking expansion, bbl. per day	2,500	Building	Early '51	.....
Vis-breaking unit, bbl. per day	7,500	Building	Early '51	.....
Sinclair Refining Co., Houston:				
Desalting unit, bbl. per day	37,000	Building	Early '51	Howe-Baker,
Sinclair Refining Co., East Chicago, Ind.:				
Vacuum unit, bbl. per day	20,000	Contracted	.....	Arthur G. McKee Co.
Socony-Vacuum Oil Co., Inc., Augusta, Kans.:				
Convert cat. cracker, bbl. per day	15,000	Building	Early '51	Fluor Corp., Ltd.
B-B depropanizer, bbl. per day	4,000	Building	Early '51	Fluor Corp., Ltd.
B-B treater, bbl. per day	3,000	Building	Early '51	Fluor Corp., Ltd.
Socony-Vacuum Oil Co., Inc., Paulsboro, N. J.:				
Naphtha reformer, bbl. per day	12,000	Building	Mid '51	C. F. Braun Co.
Socony-Vacuum Oil Co., Inc., Buffalo:				
Convert cat. cracker, bbl. per day	15,000	Building	Early '51	Bechtel Corp.
Cat. poly unit, bbl. per day	900	Building	Early '51	Bechtel Corp.
Socony-Vacuum Oil Co., Inc., Brooklyn:				
Convert cat. cracker, bbl. per day	15,000	Building	Mid '51	Foster Wheeler Corp.
Cat. poly unit, bbl. per day	900	Building	Mid '51	Foster Wheeler Corp.
Socony-Vacuum Oil Co., Inc., Trenton, Mich.:				
Convert cat. cracker	.....	Building	Early '51	.....
Socony-Vacuum Oil Co., Inc., East Chicago, Ind.:				
Convert cat. cracker, bbl. per day	15,000	Building	Late '51	C. F. Braun Co.
Standard Oil Co. (Calif.), Richmond, Calif.:				
Vacuum unit, bbl. per day	50,000	Building	Late '51	M. W. Kellogg Co.
Standard Oil Co. (Ind.), Neodesha, Kans.:				
Increase plant capacity, bbl. per day	9,300	Building	.....	.....
Add cracking facilities	.....	Planned	.....	.....
Standard Oil Co. of North Dakota, Grand Forks, N. D.:				
New refinery, bbl. per day	2,000	Planned	.....	.....
Standard Oil Co. (Ohio), Cleveland:				
Cat. cracker, bbl. per day	18,000	Building	Early '51	Bechtel Corp.
Crude unit, bbl. per day	45,000	Contracted	Late '51	Arthur G. McKee Co.

Active Refinery-Building Projects (Continued)

Company, location, and type of project—	Capacity rating	Status	Comp. schedule	Contractors
Stanolind Oil & Gas Co., Vivian (Superior), La.:				
Reforming unit, bbl. per day	1,200	Building	.....	.....
Sunray Oil Corp., Santa Monica, Calif.:				
Rebuild refinery	.....	Building	.....	.....
Sunray Oil Corp., Duncan, Okla.:				
Modernize cat. poly plant	.....	Planned	.....	.....
Reactivate alkylation plant	.....	Planned	.....	.....
Sunset Oil Co., Torrance, Santa Fe Springs, Calif.:				
Thermal cracking unit, bbl. per day	2,500	Building	.....	.....
Taylor Refining Co. and Mayfair Minerals, Inc., Port Isabel, Tex.:				
Platforming unit, bbl. per day	4,000	Building	Mid '51	Universal Oil Products Co.
Crude unit, bbl. per day	10,000	Building	Early '51	Taylor Refining Co.
Taylor Refining Co., Corpus Christi, Tex.:				
Cat. cracker, bbl. per day	8,000	Building	Mid '51	The Lummus Co.
Cat. poly unit, bbl. per day	400	Building	Mid '51	The Lummus Co.
Crude unit, bbl. per day	20,000	Building	Mid '51	Taylor Refining Co.
Gas-recovery unit	.....	Building	Mid '51	The Lummus Co.
The Texas Co., Lawrenceville, Ill.:				
Increase crude capacity, bbl. per day	20,000	Building	Mid '51	Foster Wheeler Corp.; M. W. Kellogg Co.
Cat. cracker	.....	Building	Mid '51	.....
Cat. poly unit	.....	Building	Mid '51	.....
Atmospheric unit	.....	Building	Mid '51	.....
Vacuum unit	.....	Building	Mid '51	.....
Uinta Oil Refining Co., Vernal, Utah.:				
Cat. cracker	.....	Planned	.....	.....
Union Oil Co., Edmonds, Wash.:				
New asphalt refinery	.....	Building	1951	Bechtel Corp.
Union Oil Co. of California, Oleum, Calif.:				
Crude-oil expansion, bbl. per day	3,000	Building	Early '51	.....
Utah Oil Refining Co., Salt Lake City:				
Increase boiler plant, lb. per hour	65,000	Contracted	Late '51	Stearns-Roger Mfg. Co.
Western Oil & Fuel Co., Superior, Wis.:				
New refinery	.....	Planned	.....	.....
Wickett Refining Co., Wickett, Tex.:				
Thermal cracking unit, bbl. per day	1,200	Building	Late '51	.....
Reforming unit, bbl. per day	800	Building	Late '51	.....
Wilshire Oil Co., Inc., Norwalk, Calif.:				
Poly unit, bbl. per day	600	Building	Early '51	Universal Oil Products Co.
Cat. cracker, bbl. per day	5,000	Building	Early '51	Universal Oil Products Co.
Vacuum unit, bbl. per day	15,000	Building	Early '51	Universal Oil Products Co.
Convert thermal cracker, bbl. per day	10,000	Contracted	Early '51	Universal Oil Products Co.

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REFINING

Pan-Am Expands

$6,000,000 program set for Destrehan refinery

NEW ORLEANS. — An expansion program which will bring the first catalytic cracking unit to this city's metropolitan area and add about 300,000 gal. per day to the nation's high-octane-gasoline production has been launched by Pan-Am Southern Corp. at its Destrehan refinery.

The refinery, when new facilities are placed in operation, will be able to process 20,000 bbl. daily of coastal crude and produce approximately 294,000 gal. daily of aviation gasoline, 42,000 gal. of aviation jet fuel, and about 125,000 gal. of kerosine and diesel fuel.

New facilities.—New facilities, in addition to the fluid catalytic cracker, include an alkylation unit, a hydroformer, steam-generating facilities, miscellaneous tankage, and associated auxiliaries. Construction cost is estimated at $6,500,000, and the entire program is covered by a certificate of necessity issued by the Petroleum Administration for Defense. *(The Oil and Gas Journal, March 22, 1951, page 62.)* All new facilities are scheduled to be placed in operation in 14 months.

Destrehan refinery is located approximately 18 miles north of New Orleans on the Mississippi River. It has approximately 1,100 acres fronting on the river with docks capable of berthing ocean-going tankers.

Present operations. — Present operations at the refinery have been limited mostly to asphalt production, lube blending, grease manufacturing, and terminal operations. It has about 3,000,000 bbl. of tankage and terminal products, both for Pan-Am and other companies.

Expansion of Pan-Am's refinery at El Dorado, Ark., was completed recently with the installation of a catalytic cracking unit and a large coking unit, and Dr. J. W. Bertetti, manager of the refinery, has been appointed assistant general manager of manufacturing to handle the program at Destrehan.

W.P.C. Refining Papers

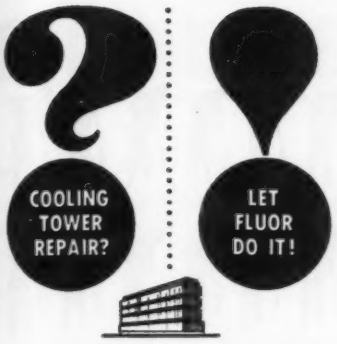
Advances in measurement and control, analysis and testing, and composition of petroleum will be discussed in papers to be presented at the Third World Petroleum Congress at The Hague, the Netherlands, May 28-June 6.

All papers will be distributed at the congress in preprint form. Among those which will deal with refining are:

"Classification and Evaluation of Crude Oils," K. W. Schneider, Germany; "Analytical Mass Spectrometry in the Petroleum Industry," W. S. Young, R. A. Brown, and F. W. Melpolder, U.S.A.; "Some Aspects of Cascade and Multi-Element Control Systems," J. C. Farquhar, U.K.; "Economics of Instrumentation in Petroleum Refining," A. M. Platt and G. L. Farrar, U.S.A.; "Spectrometric Methods of Petroleum Analysis," R. Robert Brattain, L. C. Jones, Jr., and T. P. Wier, Jr., U.S.A.

"Composes Sulfures du Propane Anlyse—Epuration," Ch. Vernet, France; "Properties of Venezuelan Crude Oils," W. L. Nelson, U.S.A., and J. Martorano Battisti and G. Thery Fombona, Venezuela; "Composition of United States and Some Foreign Crude Oils," H. M. Smith, U.S.A.; "Methods for Estimating Cetane Number," H. D. Young, U.S.A.; "Some New Measurement and Control Devices," D. J. Pompeo, J. Parker, and S. S. Smith, U.S.A.; "Isomerie des Constituants des Petroles," M. Bestougeff, France; and "Catalytic Removal of Oxygen From Sour Cracked Gases," C. G. Bertil Hammar, Sweden.

TO GET NEW LOOK.—Photos of Pan-Am Southern Corp.'s Destrehan, La., refinery taken from this same aerial perch 14 months from now will show a lot of changes—about $6,500,000 worth. New facilities, including a fluid catalytic cracker, alkylation unit, and a hydroformer will stand just below the rail lines in the center of this picture.



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Octane Ratings Reduced

KANSAS CITY, Mo.—Octane ratings of gasoline moved in Great Lakes Pipe Line Co.'s system were cut one-half to one octane number last week. The reduction is a reflection of the effect of the tetraethyl lead-conservation order recently placed in effect by the Petroleum Administration for Defense.

Great Lakes is reported to have notified its shippers that it is testing for 82 octane number on "O" and "R" grades of regular gasoline at the terminal, a reduction of one-half octane number. Also, the company is testing 89.5 octane number on "P" or premium grade, a reduction of a full number.

The company has already announced its intention to discontinue blending lead fluid with gasoline for its shippers as of April 15, and will require that shippers blend at source *(The Oil and Gas Journal, March 22, 1951, page 140).*

Socony Wins Safety Award

NEW YORK.—Socony-Vacuum Oil Co., Inc.'s, refinery at Paulsboro, N. J., has been named the safest for the past year among larger individual refineries in the world by the National Safety Council. This is the second year in a row that the Paulsboro refinery has won the award.

Safety figures showed that a Socony-Vacuum refinery worker is more than five times as safe on the job as the average industrial worker, more than four times as safe as the worker in other manufacturing activities, and more than four times as safe as the average oil-refinery worker.

Nearly 300 oil companies participated in the annual safety contest held by the council this year. Two of Socony's affiliates, General Petroleum Corp. and Magnolia Petroleum Co., also won awards in the various groups.

Refining Briefs

Union Oil Co. of California looks for Bethlehem-Sparrows Point Shipyard, Inc., to begin construction shortly of a new 143,800-bbl. tankship. Delivery of the new 17,850-ton vessel, larger and faster than any of the oil company's present seven tankers, is scheduled for mid-1952. It will cost about $5,000,000.

Standard Oil Co. (Ohio) will construct two modern crude-oil-distillation units at its Cleveland refinery this year. They will replace old crude-shell units built in 1917. The modern facilities, to cost $5,500,000, are expected to increase crude-processing capacity by 12 per cent and improve operating performance.

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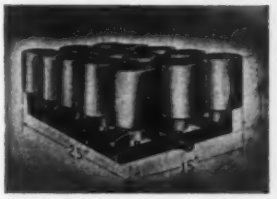

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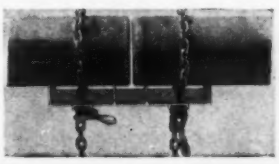

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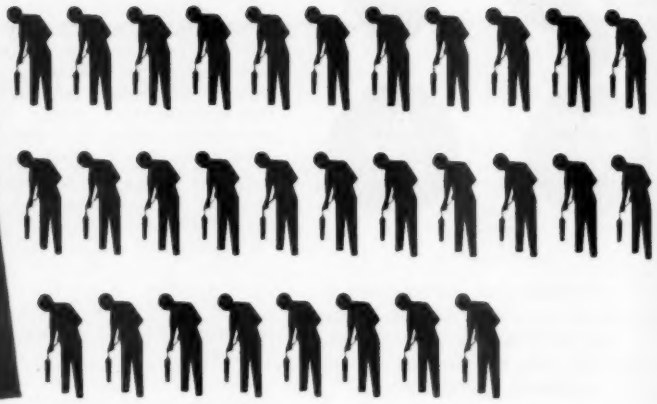

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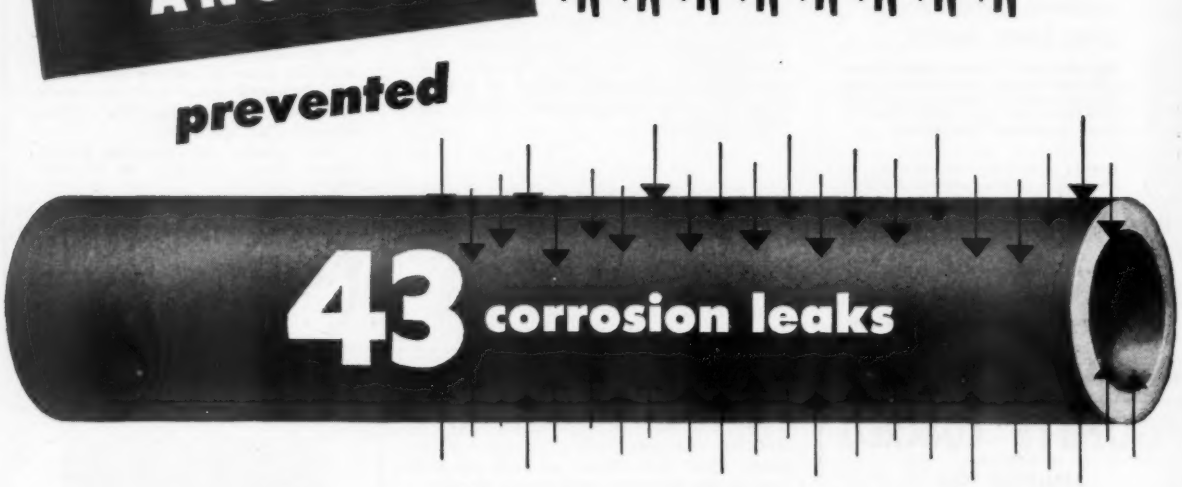

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PIPE LINES

Line O.K.'d Provisionally

SALT LAKE CITY.—Utah Public Service Commission has approved provisionally an application by Utah Natural-Gas Co. to build a $32,000,000 natural-gas pipe line from southern Utah to this city.

The commission's approval was granted providing Utah Natural will meet three conditions by April 1, 1952:

1. Unconditional commitment of a recognized financial house stating that it will supply funds for construction of the line.

2. Certificate of an independent geologist of reputation acceptable to the commission that there are proven gas reserves committed to the line adequate to justify its construction.

3. Copies of contracts with a responsible construction firm for building the line.

Failure to meet any of these requirements would render the certificate null and void.

Meanwhile Byrd-Frost, Inc., is spudding in a test in the Last Chance structure in southeast Utah. It is one of many wells the Dallas firm hopes will supply gas for the line.

B. H. Byrd, president, outlined company plans last week for the spending of $5,000,000 to $10,000,000 for development of 23 Utah geological structures believed to be oil and gas sources.

Byrd, whose company is connected with the pipe-line firm, said 768,000,000,000 cu. ft. of proven gas reserves are owned by the company in the San Juan basin of Utah, Arizona, Colorado, and New Mexico. However, he said every effort would be made to supply the line from wells to be drilled in Utah itself.

Capacity Increase Planned

SAN FRANCISCO.—Capacity of the products pipe line from Salt Lake City to Pasco, Wash., will be increased, and if the demand for products in the Pacific Northwest continues to grow, the line may be extended to Puget Sound, T. S. Petersen, president of Standard Oil Co. of California, has announced.

Making the announcement on the behalf of Salt Lake Pipe Line Co., a Standard subsidiary, Petersen said the cost of increasing the line's capacity, along with the addition of more tank storage, is estimated at nearly $1,000,000.

The company does not know at present what route the extension might take or the location of its terminus.

The expansion will boost the line's capacity from 17,500 to about 22,000 bbl. daily. Most of the increase will come from the construction of two new pump stations. The line carries such finished products as gasoline, diesel, and heating fuels.

West Virginia Line Sought

WASHINGTON.—Hope Natural Gas Co., of Clarksburg, W. Va., plans construction of a 32-mile pipe line in West Virginia to connect the company's natural-gas-transmission system with Terra Alta gas field, and has filed for Federal Power Commission approval.

The line would extend from the Fairmont area east to the gas field, located in Preston County. The company said that the line would be used primarily to transport gas from Terra Alta to its distribution area in Fairmont, but that at times gas probably would enter its general system for sale to present customers in interstate commerce.

Estimated cost of the project is $831,200. Hope estimates that 500 billion cubic feet of gas reserves may be available from Terra Alta and an adjacent new field, and that proven reserves in Terra Alta alone are 35 billion cubic feet.

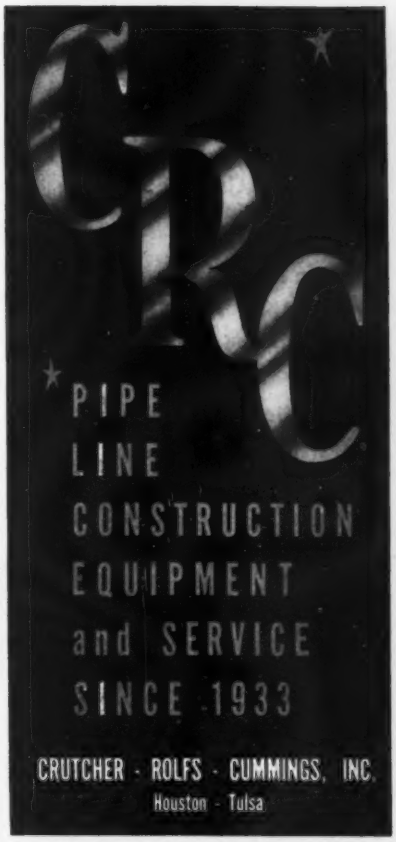
W.P.C. Pipe-Line Papers

Technical papers on transportation, storage, and distribution of crude oil and petroleum products will be delivered at the Third World Petroleum Congress, The Hague, the Netherlands, May 28-June 6. According to the program recently released by J. W. Zwartsenberg, general secretary, the papers (all to be preprinted for distribution at the meeting) will include:

"New Techniques in the Gathering, Sampling, and Measurement of Crude Oil," B. R. Walsh, E. W. Jacobson, and R. J. S. Pigott, U.S.A.; "Les Nouvelles Installations Francaises," M. M. Couteaud Deschenes, France; "Tanker Turnaround. Some Practical Aspects of the Discharge of Ocean Tankers," E. Stokoe, Belgium; "La Pollution dans le Transport par Pipe Line des Produits du Petrole," P. Lefevre, France.

"Some Technical Aspects of the Catia la Mar-Ueva Caracas Pipeline," I. V. Tullar, Venezuela; "International Petroleum Tables—Their Origin, Development, and Practical Importance," H. Hyams and H. R. Holmes, U.K.; "Les Compteurs Volumetriques de Precision," P. Sery, M. Krach, and M. de La Chapelle, France; "Progress in Oil Measurement. Standardization in the United States," L. C. Burroughs, U.S.A.

"Large-Diameter, High-Strength Pipe for Oil and Gas Transmission," Paul E. Noll, U.S.A.; "The Pressure Surge in Oil Pipe Lines," J. E. Green, U.S.A.; "Principes Generaux de Metrologie Applicables au Commerce des Produits Petroliers," M. Jacob and E. Befahy, Belgium.



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Griffis Firms Lay 1,000 Miles of Line in 3 Years

CONSTRUCTION operations of G. G. Griffis are carried on under two firm names: G. G. Griffis Construction Co., a partnership of G. G. Griffis and A. M. Griffis, and G. G. Griffis, Inc.

G. G. GRIFFIS

Officers of the latter firm are: G. G. Griffis, president and treasurer; George E. Matt, vice president and assistant secretary and treasurer; and A. M. Griffis, secretary. Griffis' interests in undertakings with Martin Wunderlich have been sold to Wunderlich.

Projects. — Since the beginning of Griffis' operations 3 years ago, Griffis firms have handled more than 1,000 miles of pipe-line work. Most of this work has been with big-inch pipe. Smallest diameters laid have been 18-in. tapering to 6-in. on 186 miles of line in Wisconsin last year for Michigan-Wisconsin Pipe Line Co.

In 1948 the most important Griffis job was reconditioning of 260 miles of 20-in. bolted-coupling line through the mountains between Maryland and Kentucky for Atlantic Seaboard Corp. Throughout the job, the line was being operated at 800 psi.

In 1949, Griffis laid 200 miles of 24-in. loops in Iowa and Minnesota for Northern Natural Gas Co. Also in 1949 in collaboration with Wunderlich, Griffis laid 112 miles of 30-in. in Mississippi and Alabama for Transcontinental Gas Pipe Line Corp. Last year, for this same pipe-line company, 130 miles of 30-in. were laid in New Jersey and Pennsylvania. Griffis also laid 78 miles of 10 to 16-in. in New Jersey for South Jersey Gas Co.

Personnel.—G. G. Griffis has been in pipe-line constrution for 30 years, during which he has served as superintendent for several contractors including Williams Brothers, N. A. Saigh, Anderson Brothers, I. C. Little, Bechtel, and Swinerton & Walberg. He sold his interest in Holland Construction Co. to go into business for himself in 1947.

George E. Matt began pipe-line work with Williams Brothers Corp.

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in 1928 on the Memphis Southeastern and Mississippi River Fuel Corp. projects. In the meantime he has been office manager and expediter for foreign projects of Williams Brothers and Oklahoma Contracting Co.

Garland Nims has recently been made general superintendent in charge of all construction. The Griffis firms have three full spreads of construction equipment capable of handling 30-in. pipe.

Offices. — Headquarters for both Griffis firms are at 2514 E. Fifteenth Street, Tulsa. Warehouses are at Appleton and Fond du Lac, Wis; Millville, N. J.; Milwaukee and on the Griffis Ranch in Rogers County, Oklahoma.

Midland Lines Announced

HOUSTON.—An extension of its facilities to provide a 75-mile, 8-in. crude-oil outlet for producing areas in Midland County, Texas, basin has been announced by Texas-New Mexico Pipe Line Co.

The extensions include a line from Midland to Germania pool, a line to serve the Scharbauer area and to connect with the Sweetie Peck area, and an extension from the company's Crane station to the new sweet-crude production in the McElroy area.

In addition, an 8-in. sweet-crude-gathering system will be extended from existing facilities at Eunice, N. M., to the Lovington and Saunders area in Lea County, New Mexico, a distance of approximately 55 miles.

Preliminary plans are being formulated by the company and construction will be governed by the availability of pipe and equipment.

Field Line Completed

ADA, Okla.—Boettcher Gas Co., of Ada, has completed a 24-mile, 6 and 8-in. natural-gas line to East Oconee field, 10 miles east of Coalgate in Coal County, Oklahoma.

The McLish sand gas-distillate well discovered in the area last year has already been connected, and operations are now under way to connect a west offset. The line ties in with the system serving plant facilities of Ideal Cement Co., of Ada.

Plans call for taking approximately 5,000,000 cu. ft. of gas per day from each of the two completed wells.

Pipe-Line Briefs

Humble Oil & Refining Co. is constructing a 6-in. pipe-line outlet for West Fort Chadbourne field of northeastern Coke County, Texas, which will tie into its 38-mile, 8-in. carrier connecting at Ballinger with the Kemper-Comyn system. Humble has four producers in the field as does Sunray Oil Corp., each with a daily allowable of 82 bbl.

Miami Valley Corp., owned jointly by Standard Oil Co. (Ohio) and Pure Oil Co., is scheduled to complete a 57-mile, 8-in. products line between Dayton and Cincinnati this spring. The new line, to cost $1,400,000, will connect at its southern terminus with Sohio's present Latonia, Ky.-Cincinnati line.

Texas Eastern Transmission Corp. has awarded Mahoney Contracting Co., of Lansing, Mich., a contract for laying 35.7 miles of 30-in. pipe line in Fayette and Westmoreland counties, Pennsylvania. The line will be used for injection and withdrawal of storage gas, and will extend from the company's main lines south of Connellsville to the New Oakford storage field near Jeannette.

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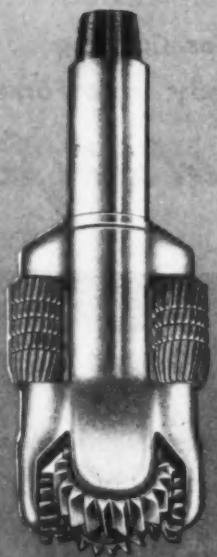

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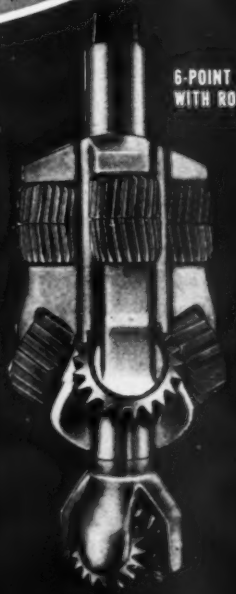

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Among the Drilling Contractors

Pike Getting Ready to Drill Mexican Wildcat

Pike Drilling Company de Mexico, wholly owned subsidiary of Thomas P. Pike Drilling Co., Los Angeles, is building roads and setting up modern camp facilities for the deep exploratory test it will drill under contract in Baja (Lower) California for Petroleos Mexicanos, Mexican Government oil agency.

Provision of roads is an important phase of the project. The drilling site is several miles inland in a barren, isolated area on the Pacific Ocean side of the peninsula where no roads previously have existed. Nearest point of access is on the beach at San Ignacio Lagoon, 600 miles south of the Mexican border, where road-building equipment, shipped by barge from Long Beach harbor, in California, was landed.

The modern camp being set up at the drilling site will provide housing, eating and recreational facilities for more than 50 men, including both Pike Drilling Co. personnel and Pemex engineers.

Drilling equipment, also shipped by barge from Long Beach harbor, is being unloaded on the beach at San Ignacio Lagoon, and will be transported to the drilling site upon completion of the road. The rig is a 10,000-ft. diesel-powered assembly. William Klassen is superintendent in direct charge of the operations for Pike.

Milton Crowe, Inc., Shreveport, has a rig running in the Dykesville field, Webster Parish, Louisiana, where it is under contract to Claud B. Hamil of Houston for 1 Wright, in 1-22n-9w.

Shamrock Drilling Co., Los Angeles, is drilling for Lumac Oil Co. at 1 Gibson-A.U.W., a wildcat test in the Northeast Richfield area, Orange County, California. Location is in 30-3s-8w.

K. L. Kellogg & Sons, Los Angeles, will drill for William R. Whittaker Co., Ltd., at 1 Reay-Whittaker, a wildcat operation in the Caliente Range area, San Luis Obispo County, California. Its location is spotted in 6-10n-25w.

Southeastern Drilling Co., Dallas, has taken a contract for a 10,250-ft. lower Cretaceous exploratory test to be drilled for Ryan Oil Co. in Copiah County, Mississippi. Location is on the Frank Smith lease, in the SE SW 27-12n-5w, about 3½ miles southwest of Myles.

Creekmore-Rooney Co., Tulsa, is moving in a heavy rig for a projected 10,500-ft. exploratory test to be drilled south of the West Velma pool, Stephens County, Oklahoma, for Deep Rock Oil Corp. Location is in the NW NW NW 31-1s-5w for 1 Massie.

Crescent Drilling Co., Monroe, La. has a substantial interest in, and the drilling contract for a deep exploratory test being started on the southwest side of the Longwood field, Harrison County, eastern Texas. The well is carried as Phillips Petroleum Co. 1 Valley. Location is in the J. B. Camp Survey. Contract is for 8,400 ft.

Davis & Whorton, Oklahoma City, have a rig in the newly opened Cushing Lake pool, northwest of Cushing, southern Payne County, Oklahoma. It now is drilling for C. E. McCaughey and associates at 1 City of Cushing, NE SE SE 28-18n-4e, 40-acre west offset to the discovery well and second test for the pool. The discovery well, T. W. and J. M. Loffland, Jr., 1 Stanolind-Amerada, produces from the second Wilcox sand at 4,015-25 ft.

Halko Drilling Co., Shawnee, Okla., is the contractor on 3,600-ft. Red Fork sand test which J. R. McLean of Dallas and Huffman & Malloy of Oklahoma City have projected for the area about 4 miles north of Prague, in Lincoln County, Oklahoma. Location is for 1 Ellison, SE NE SW 4-12n-6e.

Longhorn Drilling Co., San Antonio and Three Rivers, Tex., has contracted for a 6,500-ft. wildcat test to be drilled for Siznod Oil Corp. in Section 45 of the J. T. Maltsberger Survey, in La Salle County, Southwest Texas. Test is the operator's 2 M. L. Girard. Alva Odom will push tools for Longhorn.

Camay Drilling Co., Los Angeles, is starting a projected 5,000-ft. Miocene test for Oceanic Oil Co. on the Oxnard Plain in Ventura County, California. Location, in Projected Section 22-1n-22w, is about 2 miles south of Oxnard and 1½ miles northeast of Hueneme. Test is 1 Petit.

Dunlap & Graham, Inc., Long Beach, Calif., has a contract for a wildcat test to be drilled in the Bardsdale area, Ventura County, California, for Hellman & Hardsdale. Location is in 7-3n-19w.

Myers Drilling Co., Bakersfield, Calif., will drill Ebonoro Oil Co.'s

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projected wildcat, 1 Alves, in 15-17s-25e, Visalia area, Tulare County, California.

Sam L. Tennant Drilling Co., Blackwell, Okla., has a rig working on a projected 6,000-ft. wildcat test located in the SW SW 10-40n-9e, west of Hooper, Alamosa County, Colorado. The test, 1 Whittier, is being drilled for Orin Tucker and associates.

Postelle Drilling Co., Odessa, Tex., has a rig under contract to Intex Oil Co. for a 7,200-ft. wildcat test in Section 25, Block A-12, PSL Survey, Gaines County, West Texas. Objective is the Clear Fork formation.

Halko Drilling Co., Shawnee, Okla., has moved a rig to an outpost location north of the West Bellmont Wilcox sand pool in Lincoln County, Oklahoma, where it will drill for Frank Buttram at 1 Lovell-Barnes, SE SE SE 29-12n-5e.

Davenport Drilling Co. is the contractor on a 2,300-ft. wildcat test (1 Butts) which W. E. Atkinson and T. E. Ockerhauser of Oklahoma City are starting 6 miles west of the Loco townsite in the NE NE SW 2-3s-6w, Stephens County, southern Oklahoma.

Hubbell & Webb, Stroud, Okla., will drill a 4,400-ft. test for George W. Deck of Tulsa at 1 Taylor, NW NE SW 1-15n-5e, northeast of Kendrick, in Lincoln County, Oklahoma. The location is about a mile west of production of the Skellyville pool.

Viersen & Cochran, Okmulgee, have a contract with Bay Petroleum Corp. for a 4,300-ft. test, 1 Steincamp, in the Mt. Hope area, Payne County, Oklahoma. Location, in the SW SW SE 29-19n-4e, is about ¾ mile southeast of a lone Skinner sand producer designated as the North Mount Hope pool. Rig is being moved in.

Harbar Drilling Co., Wichita, is drilling for Sinclair Oil & Gas Co. at 1 Louise, SW SW SE 5-30-15, 2½ miles north of the Turkey Creek pool, northwestern Barber County, Kansas.

ROTARY RIGS IN OPERATION*
(United States and Western Canada)

Area—	Week ended 3-19-51	Change week ended 3-12-51	Change week ended 3-20-50
Gulf Coast	514	— 1	+ 31
W. Tex.-N. M.	797	+14	+111
Ark.-N. La.-E. Tex.	141	+ 3	+ 13
Oklahoma	288	— 5	+ 32
Kansas-S. Nebraska	148	— 8	+ 32
Illinois-Eastern	39	— 2	— 37
Rocky Mountains	106	— 7	+ 41
Pacific Coast	134	— 4	+ 13
Total United States	2,167	—10	+236
Western Canada	111	+14	+ 33
Total	2,278	+ 4	+269

*Courtesy Hughes Tool Co. Trends in drilling activity in the United States and the Pacific Coast and Illinois-Eastern areas are shown by charts on pages 392 and 393.

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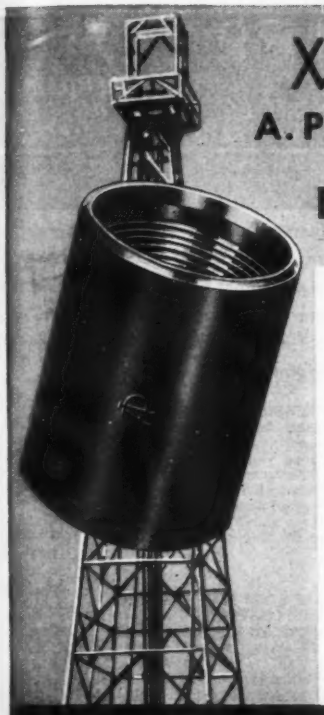

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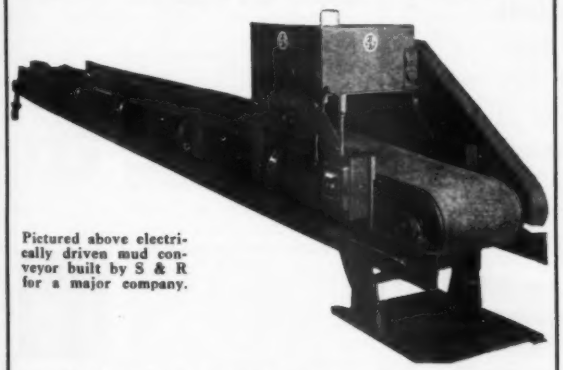

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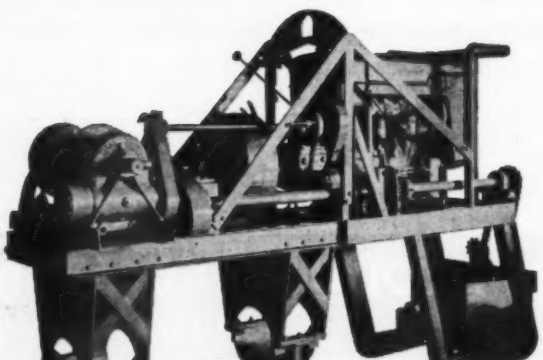

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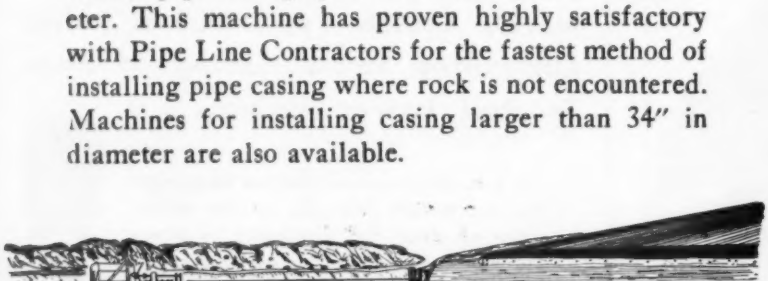

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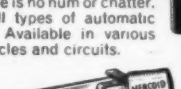

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NORMAN, Okla. — More than 80 technical papers covering all phases of gas measurement and regulation are scheduled to be presented at the twenty-sixth Southwestern Gas Measurement Short Course to be held here April 10-12.

W. H. Carson, dean of the college of engineering, will open the general assembly April 10 with an address on aims and operations of the course. M. A. Abernathy, vice president of United Gas Corp., will deliver the principal address.

Sponsors. — The course, whose purpose is to provide a means whereby men in the industry may get together to study problems of measurement and regulation of dry and casinghead gas for their mutual benefit, is sponsored by the college of engineering at the University of Oklahoma. The college is assisted by the natural-gas department of the American Gas Association, Arkansas Oil and Gas Commission, Kansas Corporation Commission, Natural Gasoline Association of America, Oklahoma Corporation Commission, Oklahoma Utilities Association, Texas Railroad Commission, and Southern Gas Association.

Subjects covered by some of the papers include: Field measurement at extremely high pressures, thermometers and gages, meter charts, and records, specific gravity, gas laws, gas accounting, recording calorimeters, orifice meters, ironcase - meter manufacturing, gas gravitometers, displacement meters, load distribution, regulators, leakage, supercompressibility factors, gas-sample analysis, efficiency, manometers, and many others. Papers include:

"Methods of Determining the Specific Gravity of Gas," W. F. Hoag, Phillips Chemical Co.; "Determination of Gasoline Content of Natural Gas," J. A. Schultz, Phillips Petroleum Co.; "Gas Regulation at Extremely High Pressures," E. S. Plank, Tennessee Gas Transmission Co.; "Measurement Problems Involved in Underground Storage," Charles R. Stephenson, Michigan-Wisconsin Pipe Line Co.; "Determination of Leakage and Unaccounted-for Gas in Distribution Systems," E. M. Harris, United Gas Corp.

"Determination of Water Vapor in Natural Gas," James H. Kelly, Texas Eastern Transmission Corp.; "Measurements for Pipe Line Efficiency," J. D. Killough, United Gas Pipe Line Co.; "Dehydration of Gas at the Well Head," Laurance S. Reid, University of Oklahoma; "Measuring Gas for Lift Operations," D. McDonald, Jr., Magnolia Petroleum Co.; "Deliverability Method of Rating Gas Wells," Charles B. Peterson, University of Texas; "Remote Recording and Control," W. E. Rufleth, Bristol Co.

"Back Pressure Tests of Gas Wells," Elmer Capshaw, Oklahoma Corporation Commission; "Recent Legislation Affecting Gas Measurement," Charles A. Breitung, Texas Railroad Commission; "Problems in Measurement of Natural Gas Containing Hydrogen Sulphide," Terrell Hamaker, Arkansas Fuel Oil Co.; "Principles of Automatic Control," Win Rochelle, Foxboro Co.

January Sales Set New High

NEW YORK.—Sales of natural gas reached an all-time high in January, setting a new mark of 4,743 million therms, an increase of 19.3 per cent over sales in January 1950, which registered 3,976 million therms.

The American Gas Association's index of sales was 388.3 per cent of the 1935-39 average. The association said that beginning with January 1951 it would combine sales of manufactured and mixed gas. Conversions by utility companies from manufactured to either natural or mixed gas and from mixed gas to natural gas have been so great recently that sales figures in these categories are subject to wide variations.

During the 12 months ended January 31, sales of natural gas were 39,373 million therms, an increase of 19.5 per cent over the same period a year ago.

Piedmont Seeks Gas Supply

WASHINGTON. — Piedmont Gas Co., Inc., of Hickory, N. C., has filed a request with the Federal Power Commission that Transcontinental Gas Pipe Line Corp., of Houston, be ordered to supply gas for a system of natural-gas lines which Piedmont proposes to build in North Carolina.

In addition to supplying the gas, Transcontinental would be required to establish connections between its main-transmission system and Piedmont's proposed 28 miles of 6-in. lines.

Annual requirements of the system are estimated at 201,933,000 cu. ft., with a peak day of 1,203,000 cu. ft., during the first year of operation and at 716,916,000 cu. ft., with a peak day of 4,963,000 cu. ft., during the fifth year.

Gas Facilities Approved

WASHINGTON.—Southern Natural Gas Co., of Birmingham, has received the go-ahead signal from the Federal Power Commission to construct natural-gas facilities in Carroll County, Georgia. The authorization was conditioned, however, to require the company to supply natural gas to six communities in Alabama.

Southern Natural had filed exceptions to the part of a presiding examiner's decision in an earlier hearing which found that the company had sufficient excess capacity to supply the six communities as well as to supply 223,000,000 cu. ft. per day to Atlanta Gas Light Co. as required by contract.

The company's project includes 3½ miles of 24-in. loop line and an additional 700-hp. capacity at it Tarrant compressor station. Estimated cost of construction is $287,840.

Alabama communities which intervened in the proceedings to obtain service were Hokes Bluff, Helena, Eden, Columbiana, Morris, and Warrior. The commission pointed out that Southern Natural has 45,000,000 cu. ft. excess capacity over its contracted peak-day requirements for the 1951-52 winter season, while peak-day requirements of the communities in the fifth year of operation totaled only 1,687,800 cu. ft.

Natural Gasoline

Skelly Enlarges Plants

An extensive program for the expansion of Skelly Oil Co.'s natural-gasoline production is now under way, William G. Skelly, president, has announced.

The company plans to expand facilities of its Eunice No. 1 and No. 2 natural-gasoline plants in Lea County, New Mexico, to process an additional 30,000,000 cu. ft. of gas per day. Purchase of materials and engineering design are already proceeding to double the capacity of Skelly's Velma plant in Stephens County, Oklahoma.

Enlargement and revamping of Crawford and Watkins natural-gasoline plants in the Texas Panhandle to provide gas-injection service for repressuring oil-producing wells in that area have been completed and operation has begun.

Contracts have been made for the sale of the increased volume of residue gas after the extraction of liquid products at all these plants.

Ulysses Plant Authorized

WICHITA.—The conservation division of the Kansas State Corporation Commission has approved construction by Stanolind Oil & Gas Co., of a natural-gasoline plant near Ulysses, Kans.

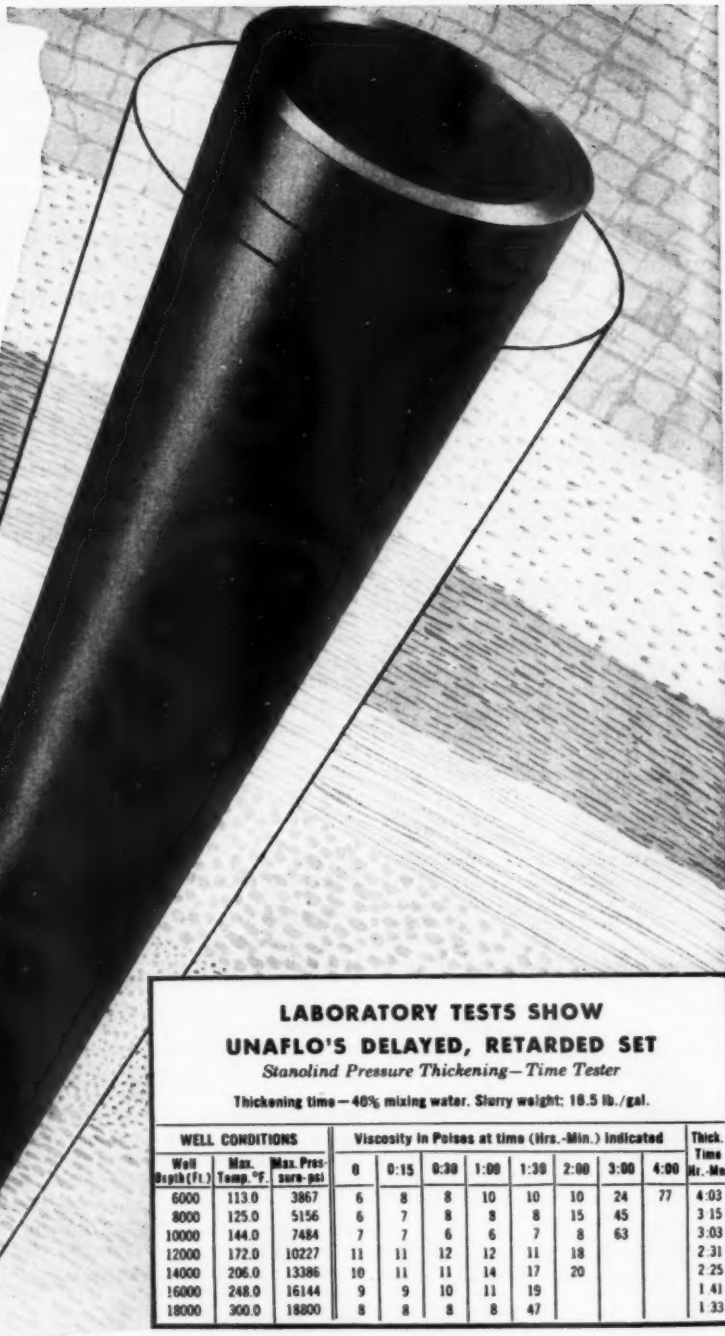
The new plant, according to present plans, will process approximately 70,000,000 cu. ft. of gas per day from Hugoton field. It will manufacture liquefied petroleum gases and natural gasoline. Kansas Power & Light Co., of Topeka, Kans., has contracted for residue gas from the plant.

Hugoton-Plains Gas & Oil Co. has filed application for a gasoline plant to be built near Hugoton. This application will be considered by the commission at its meeting on March 27.

XUM

To date, no depths too great for

UNAFLO*



Unaflo has proved itself in the deepest and hottest wells. Just as it is safe to use in such wells, it is equally dependable in those of non-record depths, temperatures, pressures.

If there *is* trouble below, Unaflo's sustained fluidity gives time to make repairs and complete the job... or back off and wash out the cement.

On your next cementing job insist on Unaflo 3-way protection:

1. Easy pumping—Unaflo has high initial fluidity. This makes pumping easier, permits use of heavy slurries when they're needed.

2. Retarded set—Unaflo isn't just slow-setting. It stays fluid and pumpable throughout the retardation period, gives you ample time, even in emergencies, to get cement in place.

3. Dense seal—A heavy slurry of Unaflo hardens normally after retardation to form a tight seal, resistant to sulfate waters.

To be sure... always protect your investment with Unaflo.

* * *

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LABORATORY TESTS SHOW
UNAFLO'S DELAYED, RETARDED SET
Stanolind Pressure Thickening—Time Tester

Thickening time—40% mixing water. Slurry weight: 16.5 lb./gal.

WELL CONDITIONS			Viscosity in Poises at time (Hrs.-Min.) indicated								Thick. Time
Well Depth (Ft.)	Max. Temp. °F.	Max. Pressure-psi	0	0:15	0:30	1:00	1:30	2:00	3:00	4:00	Hr.-Min
6000	113.0	3867	6	8	8	10	10	10	24	77	4:03
8000	125.0	5156	6	7	8	8	8	15	45		3:15
10000	144.0	7484	7	7	6	6	7	8	63		3:03
12000	172.0	10227	11	11	12	12	11	18			2:31
14000	206.0	13386	10	11	11	14	17	20			2:25
16000	248.0	16144	9	9	10	11	19				1:41
18000	300.0	18800	8	8	8	8	47				1:33

"UNAFLO" is the registered trade mark of the retarded oil-well cement manufactured by Universal Atlas Cement Company

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OIL-FIELD CEMENTS

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Resistant to Sulfate Waters
Atlas Portland Cement—Type I

Atlas Portland Cement—Type II
Resistant to Sulfate Waters
Atlas High-Early Cement—Type III

OG-U-120

"THE THEATRE GUILD ON THE AIR"—*Sponsored by U. S. Steel Subsidiaries—Sunday Evenings—NBC Network*

Up-An'-Comin' Upton

STEALING the spotlight in the busy Midland basin province of the Permian basin is Sinclair Oil & Gas Co. 1 McElroy Ranch (A on map) in Upton County, Texas. This deep wildcat well has already shown for flowing, water-free production at high rates throughout 225 ft. of Ordovician-Ellenburger section and is digging for more.

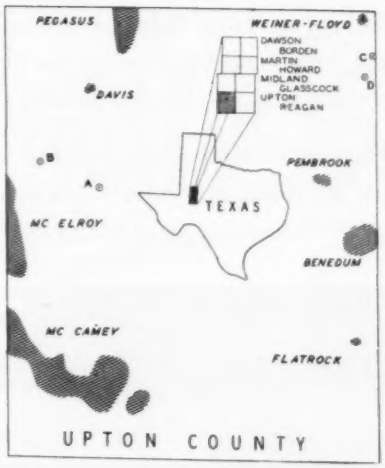
It would be premature to suggest that a major pool has been opened by Sinclair's well—too many big wells on geologically "ideal" locations have been offset by duds. The deep fractured Ellenburger dolomites of West Texas are especially tricky and informed observers view Sinclair's discovery with a certain amount of reservation. However, each new drill-stem test at this big well is resulting in accelerating enthusiasm for the potentialities of the immediate area. Here is a brief story of the well.

After showing as a flowing discovery from the Pennsylvanian-Strawn at 9,376-9,411 ft. Sinclair's wildcat was drilled ahead to top the Ellenburger at 12,042 ft. There have been five drill-stem tests run in the Ellenburger with ¾-in. bottom and 1-in. top chokes: 12,042-12,110 ft.—recovered 1,770 ft. of free oil; 12,102-49 ft.—flowed 285 bbl. of oil in 2 hours; 12,154-12,209 ft.—flowed 100 bbl. of oil in 2 hours; 12,212-78 ft.—flowed 575 bbl. of oil in 4 hours; 12,282-12,328 ft.—flowed 105 bbl. of oil in 1 hour.

The oil has been 52°-54° gravity. Gas-oil ratios have been about 300 to 1, low for wells high on steep Ellenburger structures. Flowing pressures up to 4,500 psi. and shut-in bottom-hole pressures (30 minutes) up to 5,375 psi. have been recorded.

Three offset wells to this dual-zone discovery well have been started. Sinclair is drilling a south offset and Wilshire Oil Co. is drilling west and northwest offsets. The results of these wells will go a long way toward determining if another Pegasus-Ellenburger has been found. To the west and separated from Sinclair's well by two dry holes is Gulf Oil Corp. 1-H McElroy Ranch (B on map), an Ellenburger test drilling below 10,300 ft. Discovery well of Davis-Ellenburger pool was completed last December by Sinclair.

It is not only Sinclair's discoveries



that is keeping Upton County a center of interest, however. The Permian-lower Leonard-Spraberry, which is responsible for so much activity throughout the eight counties pictured on the map, is yielding promising results in Upton.

Weiner-Floyd was recently opened by Ted Weiner 1 Braden. Now, Weiner 1-40 Proctor (C on map) has indicated another possible discovery from the Spraberry. Ashland Oil & Refining Co. 1 Sherrod (D on map) is being completed for a small producer in the tight Spraberry sand. Several Spraberry tests have been announced for this general area and development of these sands topped at about 7,000 ft. is expected to be rapid. Pembrook, discovered a little over a year ago, now has eight Spraberry producers. Spraberry production is also being developed at Benedum multipay field. Flatrock, discovered by Cities Service Oil Co. and Continental Oil Co. 1-AH University in January, is producing from the Ellenburger but flowed oil from the Spraberry on a drill-stem test.

The large fields in the southwestern corner of Upton County are in the Central Basin platform province. They produce principally from the Permian-Grayburg. There are several small pools in the county which are not shown on the map.

Philip C. Ingalls.

HIGHLIGHTS OF WEEK'S DEVELOPMENTS

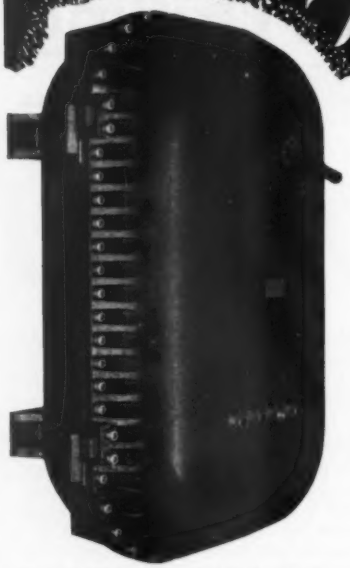
WEST TEXAS.—Further testing uncovered a total of 226 ft. of pay in the Ellenburger at Sinclair Oil & Gas Co. 1 McElroy, Upton County discovery. Last reported test, to 12,328 ft., gaged 105 bbl. of oil in 1 hour. It was to core ahead. Timmerman field of west central Midland County had a second producer at Magnolia Petroleum Co. 1 Arch Benge, one location southeast of the opener. On completion potential it flowed 301 bbl. of oil a day through 24/64-in. choke.

ROCKY MOUNTAIN AREA.—Amerada Petroleum Corp. is now perforating and testing at its 1 Iverson, deep wildcat in Williams County, North Dakota. Phillips Petroleum Co. recovered water from the Dakota at the 1 Tank Farm, Careyhurst, Wyoming, wildcat. Standard of California and Continental Oil Co. are drilling below 3,980 ft. at the 1 Unit in White Pine County, Nevada.

OKLAHOMA.—W. A. Delaney, Jr., 1 Oscar Ewton, SE SW 17-11n-23w, discovery well in southern Roger Mills County, swabbed at the rate of 1½ bbl. of net oil per hour through casing perforations at 10,760-93 ft. Carter Oil Co.'s prospective discovery well, 1 Garrett, SE SE SE 32-11n-25w, in northwestern Beckham County, has cemented casing at 10,295 ft. and is preparing to core ahead. Mazda Oil Corp. has extended production of Ringwood pool in Major County, 2½ miles to the northwest at its 1 Walker, NE SW SW 22-22n-11w.

WESTERN KANSAS.—Swabbing tests of I. W. Siegel's prospective discovery well 1 Schraeder, NW SE NW 3-24s-24w, in Hodgeman County, produced at the rate of 40 bbl. of oil per hour from the Mississippian.

Now! A SIZE 5 EXPLOSION-PROOF STARTER with AIR CIRCUIT BREAKER



The "NEMCO" Size 5 Explosion-Proof Combination Motor Starter with Air Circuit Breaker — — for use in Class 1, Group D Hazardous Locations. "Start-stop" control station and reset buttons are mounted in cover.

The "NEMCO" Size 5 Explosion-Proof Combination Motor Starter is probably the only starter of its size and type to be manufactured in the combination air-break form.

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Texas Gulf Coast

New Oil Field Is Opened In East Jackson County

HOUSTON. — Sun Oil Co., et al, have opened a new oil field just north of the town of Francitas in eastern Jackson County, at 1 Rogers Unit. The well was completed for 208 bbl. of 46.7°-gravity oil daily through ⅛-in. choke. The hole was drilled to a total depth of 10,000 ft. after setting 7-in. casing to 9,500 ft. for protection. A bad leak in the casing was detected at 6,507-12 ft. and operators spent considerable time in sealing it off. The well was finally completed through perforations at 8,649-51 ft. with 8 shots. It is located on Lot 1,043 of Block 11 of Subdivision "A," Francitas Frams, aproximately 1½ miles north of Francitas.

New pay has been established at Batson field, Hardin County, at Atlantic Refining Co. 7 Lou Cruse. Through perforations in Yegua sand at 5,175-210 ft., the well was potentialed for 174 bbl. of 41.4°-gravity oil daily. Flow was gaged through a 10/64-in. choke, and tubing pressure was 475 psi. Hole is bottomed at 6,002 ft. and has 7-in. casing cemented to 5,975 ft. The new sander is located in F. H. Green Survey, Abstract 24.

In Colorado County, Superior Oil Co. is still testing D-1 Mrs. Mathilda Tait, John Byrne Survey, Abstract 10. On latest test, the well flowed 1,810,000 cu. ft. of gas per day plus condensate through 20/64-in. choke. Flow was through perforations at 10,849-91 ft. Tubing pressure was 910 psi. Operator squeezed perforations and is preparing to perforate and test from 10,760-70 ft. Production was assured when on an earlier drill-stem test from 10,726-72 ft., using ¼-in. bottom and 10/64-in. top chokes, the well developed 2,800 psi. working pressure and flowed 5,375,000 cu. ft. of gas per day plus 42 bbl. of 49°-gravity condensate.

American Republics Corp. and Houston Oil Co. have finaled 1 M. B. Hughes, et al, Henry Webb Survey, Abstract 42, Jasper County, for a new oil discovery. On potential test through perforations at 6,922-94 ft., the well flowed 64 bbl. of 40.5°-gravity oil daily through 7/64-in. choke. Tubing pressure was 675 psi. The wildcat was drilled to a total depth of 8,103 ft. and operators set 5½-in. casing to 7,370 ft. The new discovery is located 2 miles north of Bessmay.

The deepest test for oil ever drilled in Texas apparently is being drilled by John Mecom on the north flank of Hull dome in Liberty County. The operator has applied for permit to drill D-6 Merchant to 17,000 ft. The test is now bottomed at 12,508 ft. with 7-in. casing cemented to 12,507 ft. This is believed to be the longest string of 7-in. ever set in a Texas well.

TEXAS GULF COAST (DISTRICTS 2 AND 3) SUCCESSFUL WILDCATS

Austin County: Gas-condensate discovery—Sun Oil Co. 1 Mikeska, S. F. Austin 4 League Gr., 6 mi. NW of Bellville, TD 10,505 ft., perf. 9,313-23 ft., IP: 151 bbl. condensate per day, ¼-in. choke, TP 1,150 psi., SITP 2,575 psi., 57.6° gravity.

Colorado County: Gas discovery—Oil Drilling Co. 1 Carruth, et al, Hays, Crawford & Holden Sur., TD 9,936 ft., perf. 8,418-28 ft., IP: 5,200,000 cu. ft. of gas per day, open flow, SIP 3,200 psi.

Galveston County: Oil discovery—Stanolind Oil & Gas Co. 4 League, Martin Dunman Sur., TD 5,153 ft., perf. 4,536-53 ft., IP: 13 bbl. oil per day on pump, no potential made.

Hardin County: New pay at Batson—Atlantic Refining Co. 7 Lou Cruse, F. H. Green Sur., A-24, TD 6,002 ft., perf. Yegua 5,175-210 ft., IP: 174 bbl. oil per day, 10/64-in. choke, 41.5° gravity, TP 475 psi.

Harris County: New pay at Durkee—Petrex Oil Corp. 1 Sadie H. Southard, George Green Sur., A-281, perf. tubing (new sand) Look sand 7,196-204 ft., IP: 259 bbl. oil per day, 9/64-in. choke, TP 825 psi., 34° gravity, perf. casing Fairbanks sand 7,048-50 ft., IP: 193 bbl. oil per day, 10/64-in. choke, CP 700 psi., 34.4° gravity.

Refugio County: Gas discovery—Kirkwood & Morgan, Inc., 1 C. H. Dean, Jose Maria Gregoria Cobian Sur., TD 5,468 ft., perf. 2,717-22 ft., IP: 125,000,000 cu. ft. gas per day, open flow, SIP 1,109 psi.

Oil discovery—Union Oil Co. of California 2 J. J. O'Brien Refugio Town Tract Sur. A-345, TD 6,550 ft., perf. 5,853-58 ft., IP: 82 bbl. oil per day, 9/64-in. choke, TP 375 psi., 38.7° gravity, OWDD originally abandoned 3,448 ft. December 28, 1950.

TEXAS GULF COAST (DISTRICTS 2 AND 3) WIDCAT FAILURES

Bee County: Bridwell Oil Co. 1 F. J. Sugarek Estate, D. Dougherty Sur. A-158, 10 mi. SW of Beeville, dry, TD 4,406 ft.

Brazoria County: Sam G. Harrison 2 Houston Farms Development Co., Perry & Austin Sur., A-109, dry, TD 7,200 ft.

Rowan Oil Co. 1 Lester Knape, William Harris Sur., A-72, dry, TD 10,300 ft.

Burleson County: J. Krchnak, England & England 1 Coline, James Lastley Sur., A-25, dry, TD 2,116 ft.

Calhoun County: John W. Mecom 11 Minnie S. Welder, Cuadrilla Irrigation Co. Sur., A-165, dry, TD 9,251 ft.

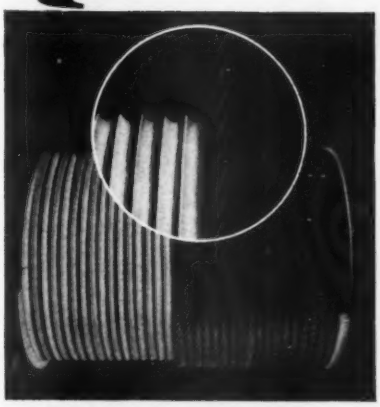
Fort Bend County: Goldston Oil Corp. 1 Turner, J. H. Polley Sur., A-70, 15 mi. SE Rosenberg, dry, TD 4,809 ft.

SAVES

WIRE LINE & DRILLING Costs

LEBUS

WIRE LINE GROOVING and SPOOLING SYSTEM

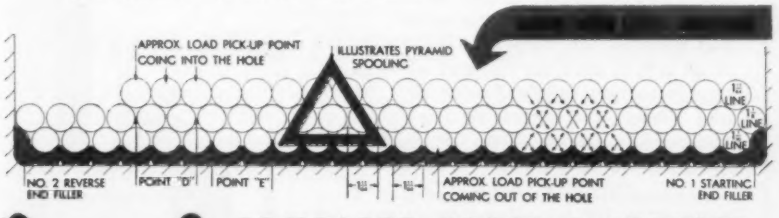


This photograph and insert is a drawworks drum with the LeBus Wire Line Grooving and Spooling System installed and with the first layer of line wrapped to the preferred pick-up point when coming out of the hole to change bits.

Now more than ever before, drilling Contractors are concerned with the conservation of hard-to-get materials and equipment. Major savings can be had — not only in labor but in the lengthening of the life of Wire Line through the use of the LeBus Wire Line Grooving and Spooling System. The Pinching, Squeezing, Crowding and Mis-shaping of the Wire Line on Plain or Flat Drums has always been wasteful to Wire Line plus being hazardous and time consuming to the drilling crew. These Wire Line Troubles are remedied when your drum is grooved with LeBus Grooving and End Fillers as shown on the drawing of a grooved drum below. Even a tapered or distorted line spools evenly and safely on a grooved drum. The loads line up as indicated by crossed arrow and the wraps "Pyramid" as shown with large triangle. This controlled contact and even loads mean longer life for Wire Line and safer drilling operation.

Theoretical illustration of the Spooling of a Tapered or Stretched 1⅛" Wire Line. A.P.I. Tolerance 1⅛ + 1/64 or — 0 Diameter.

This print illustrates that less line is required on a LeBus grooved drum, when the pipe has been picked up to the required height for making connections.


APPROX. LOAD PICK-UP POINT COMING INTO THE HOLE
ILLUSTRATES PYRAMID SPOOLING
1st LINE
2nd LINE
3rd LINE
NO. 2 REVERSE END FILLER
POINT "D"
POINT "E"
APPROX. LOAD PICK-UP POINT COMING OUT OF THE HOLE
NO. 1 STARTING END FILLER

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Jackson County: T. J. Ahern, et al, 1-D T. N. Mauritz, et al, M&C Sur., A-236, dry, TD 6,209 ft.

Montgomery County: PLD Well Service 1 Goff, et al, Neil Martin Sur., A-26k, 5 mi. W of Willis, dry, TD 7,516 ft.

Louisiana-Arkansas

South Sarepta Gets First Oil Production

SHREVEPORT. — The first oil well for South Sarepta field, Bossier Parish, has been brought in at Magnolia Petroleum Co.'s 1 Ansel Stroud, 16-22n-11w. The field has four gas or distillate wells, all operated by Sunray Oil Corp., which is currently coring at its fifth venture, the 1 Northcott in Section 29.

On a 24-hour test, the new Magnolia well gaged 115 bbl. of 48°-gravity crude from the Ardis sand through perforations at 9,366-75 ft. Gas-oil ratio was 1,700-1, and tubing pressure was 450 psi.

Sunray opened the field with its 1 Ardis unit, Section 27-22n-11w. The corporation's other wells include: 1 Whittington, Section 28; 1 Jackson unit, Section 22; 1 Bolinger (dual completion), Section 21.

NORTH LOUISIANA WILDCAT FAILURES

Catahoula Parish: Ballew, Gullman & Johns 1 Brown, C NE SE NE 9-7n-6e, elev. 63 ft. DF, dry, TD 6,255 ft., no tops reported.

Justiss-Mears Oil Co. 1 McGraw, 330 ft. N and 80 ft. W of SE corner 24-10n-8e, elev. 69 ft. DF, dry, TD 6,044 ft., no tops reported.

Franklin Parish: McAlester Fuel Co. 1 Munholland "A," 962 ft. N and 326 ft. W of SE corner 6-15n-8e, elev. 87 ft. DF, dry, TD 4,113 ft., chalk 3,135 ft.

ARKANSAS SUCCESSFUL WILDCAT

Franklin County: Arkansas-Western Gas Co. 1 Arkansas-Western, 100 ft. N of center 16-10n-28w, Lone Elm, 3½ mi. NW White Oak field, 20,000 cu. ft. of gas per day from Atoka at 2,265-91 ft. and 2,627-39 ft., TD 3,584 ft.

ARKANSAS WILDCAT FAILURES

Crittenden County: J. S. Patterson 2 Magness, SW SE SW 25-8n-6e, 2½ mi. NE Earle, dry, TD 3,260 ft., no tops reported.

Franklin County: Arkansas-Western Gas Co. 1 McGehee, CWL E/2 17-10n-28w, 1 mi. W Lone Elm, dry, TD 3,715 ft., slight show of gas 2,755 ft. and 3,615 ft.

Madison County: Ussery 1 Jones, SE NE SW 21-15n-27w, dry, TD 982 ft.

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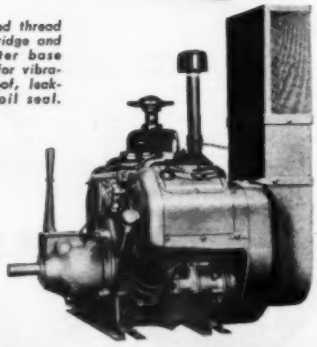

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Eastern Texas

New Producer Assured on South Edge of Sandusky

DALLAS.—A new producer on the south edge of Sandusky field of Grayson County was assured at Kimbell & Sims 1 T. L. Miller, S. Carmena Survey. A drill-stem test at 7,185-87 ft. in the Oil Creek sand had gas in 15 minutes and oil in 21 minutes. It was allowed to flow for approximtely 40 minutes but was not gaged. Pipe was being pulled at last report; perforations were to be made from 7,170-76 ft. for completion. The well had recovered heavily oil and gas-cut mud on a test of the Strawn at 6,951-88 ft.

Grayson County received a new exploration test, to 8,500 ft., at George W. Humphrey 1 Barnes Heirs. Location has been made in the William Allen Survey, 3 miles southwest of Hagerman, and about 1 mile east of an Ellenburger failure drilled by Denver Producing & Refining Co. several years ago.

In Anderson County, new Woodbine production was in prospect at Douglas McCrary 1 Southern Pine Lumber Co., T. N. Jones Survey. A drill-stem test from 5,270-76 ft. was said to have made a flow of 43°-gravity oil, reaching the surface in 10 minutes.

The Texas Co. 1 Lula Mason, J. L. Chavert Survey, Limestone County wildcat, developed approximately 48 bbl. of distillate in 12 hours, flowing through ¼-in. choke from upper Pettit perforations at 7,305-25 ft. Another report on the same perforations placed an estimate on the gas at 2,000,000 cu. ft. daily, flowing through 12/64-in. choke. The well also indicated production from the Rodessa section before pipe was set, which was to be tested further.

A new pay discovery in Ham Gossett field of Kaufman County was said to be the county's most prolific producer. T. D. Humphrey & Sons 1 Annie Fritz, E. Fitzgerald Survey, made a natural flow of 455 bbl. of oil in 24 hours, through 12/64-in. choke from the Rodessa limestone at 6,223-37 ft. Other pays in the field are the Woodbine and the Bacon limestone.

The 1 Fritz also showed for production from a possible fourth zone, the Mooringsport of the Glenrose, which flowed at the rate of 25 bbl. of oil hourly from a section at 5,780-85 ft. Operators have applied for dual-completion permit.

EAST TEXAS (DISTRICTS 5 AND 6) WILDCAT FAILURES

Falls County: H. H. Hamilton 1 A. D. Guderin, I. Galindo Sur., 7 mi. N Chilton, dry, TD 1,711 ft., Buda 828 ft., Georgetown 915 ft., Edwards 1,065 ft.

Houston County: E. L. Howard and Ralph Spence 1 S. Womack, John Durst Sur.,

4 mi. NE Percilla, dry, TD 5,904 ft., base Austin 5,818 ft., Woodbine 5,862 ft.

Marion County: J. H. Buchanan 1 D. H. McNeely, J. C. Lawhorn Sur., 2 mi. SE Smithland, dry, TD 3,447 ft., elev. 207 ft., Blossom sand 2,140 ft.

Titus County: J. Z. Werby 1 Forst Franch, R. W. Nabors Sur., 5 mi. S Mount Pleasant, dry, TD 5,750 ft., elev. 305 ft., Pecan Gap 2,291-2,765 ft., Fort Worth 4,640 ft., Paluxy 5,535 ft.

Kansas

Second Pool Assured For Hodgeman County

SWABBING tests of I. W. Siegel's prospective discovery well 1 Schraeder, NW SE NW 3-24s-24w, in Hodgeman County, western Kansas, produced at the rate of 40 bbl. of oil per hour. The well is testing saturation found in the Mississippi dolomite, topped at 4,655 ft. (—2,174 ft.), and drilled to 4,683 ft. Hole is open in the pay from 4,665 ft. Gravity of the oil is 44.7°. Completion of the well will open the second pool for the county. The location is 7 miles southwest of the town of Jetmore and about 9 miles southwest of the Jetmore pool, the county's only other pool, opened last year by Shell Oil Co.

Jones, Shelburne & Farmer 1 Lynd, SE SE SE 32-9-19, another indicated pool-opener, located 2 miles northeast of the Berland pool, in southwestern Rooks County, filled 2,000 ft. with oil when plug was drilled out to test Arbuckle lime. Swabbing is under way. Total depth is 3,747 ft. with top of the pay at 3,749 ft. (—1,544 ft.).

KANSAS SUCCESSFUL WILDCATS

Barton County: B & R 1 Johnson, SW SW SW 27-19s-12w, elev. 1,812 ft., pumped 174 bbl. of oil per day from Arbuckle at 3,362-68 ft., TD; anhydrite 650 ft., Heebner 2,983 ft., lime 3,101 ft., Lansing-Kansas City 3,120 ft.

Ellsworth County: Imperial Petroleum Co. 1 Mathews, NW SE NW 19-17s-10w, elev. 1,838 ft., 1,013 bbl. of oil per day from Lansing-Kansas City at 3,080-85 ft., TD; anhydrite 615 ft., Topeka 2,750 ft., Heebner 2,866 ft., Douglas 2,894 ft., lime 2,975 ft., opens Mathews field.

Rice County: Dozier (was Phil-Han) 1 Kolina, NE NE SW 3-18s-8w, elev. 1,778 ft. DF, 165 bbl. of oil per day from Sooy (?) at 3,214-28 ft., 3,242-46 ft., and 3,250-54 ft., TD 3,282 ft., OWWO, new zone in Edwards field.

Stafford County: Bird 1 Wright, NE NE NE 14-21s-14w, elev. 1,921 ft., pumped 258 bbl. of oil per day from Lansing-Kansas City at 3,483-88 ft., TD 3,699 ft., anhydrite 825 ft., Heebner 3,236 ft., Toronto 3,255 ft., Douglas 3,280 ft., cherty Viola 3,609 ft., Arbuckle 3,695 ft., opens Northwest McGinty field.

KANSAS WILDCAT FAILURES

Barton County: Franco Central and Lauck 1 Cain, SW SW NW 7-16s-12w, elev. 1,886 ft., dry, TD 3,443 ft., anhydrite 840 ft., Heebner 3,017 ft., Douglas 3,069 ft., lime 3,105 ft., Lansing-Kansas City 3,118 ft., Sooy 3,389 ft.

Butler County: Williams 1 Chance, NW NE NE 7-28s-3e, elev. 1,337 (?) ft., dry, TD 3,175 ft., Topeka 1,435 ft., Heebner 1,807 ft., Douglas 1,887 ft., Stalnaker 2,025 ft., Lansing 2,045 ft., Kansas City 2,380 ft., Marmaton 2,609 ft., Mississippi lime 2,876 ft., Kinderhook 3,059 ft., chat 3,111 ft., Misener 3,124 ft., Simpson shale 3,125 ft., Simpson sand 3,144 ft.

Dozier 1 Martin, NW NW SE 8-28s-3e, elev. 1,336 ft., dry, TD 3,171 ft., Lansing 2,019 ft., Kansas City 2,385 ft., Mississippi lime 2,938 ft., Simpson 3,133 ft.

Chase County: Mendenhall et al., 2 Piper, NW SW NW 14-20s-9e, elev. 1,363 (?) ft., dry, TD 3,080 ft., Marmaton 1,863 ft., Cherokee 2,116 ft., Bartlesville 2,325 ft., Mississippi lime 2,555 (?) ft., Kinderhook 2,763 ft., no Hunton, Viola 2,871 ft., Simpson 2,947 ft., Arbuckle 3,023 ft.

Ellsworth County: Todd 1 Doubrava, NE SW SE 6-17s-10w, elev. 1,913 ft., dry, TD 3,407 ft., anhydrite 690 ft., Heebner 2,943 ft., lime 3,049 ft., Lansing-Kansas City 3,063 ft., cherty Sooy 3,369 ft., Arbuckle 3,380 ft.

Phillips County: Harbar et al., 1 Holsman, NE NE NE 26-1s-18w, elev. 2,185 ft., dry, TD 3,675 ft., Heebner 3,468 ft., Lansing-Kansas City 3,497 ft.

Musgrove 1 Steenis, SE SW NE 11-1s-19w, elev. 2,056 ft., dry, TD 3,520 ft., Heebner 3,255 ft., Toronto 3,282 ft., Lansing-Kansas City 3,286 ft.

Rice County: Sterling-Plains Exploration 1 Humphreys, SE SE SW 3-21s-8w, elev. 1,644 ft., dry, TD 3,695 ft., Heebner 2,746 ft., Dodge 2,757 ft., lime 2,885 ft., Lansing-Kansas City 2,916 ft., Sooy 3,273 ft., Mississippi lime 3,297 ft., Kinderhook 3,328 ft., Misener 3,425 ft., Maquoketa 3,431 ft., Viola 3,587 ft., Simpson 3,610 ft., Arbuckle 3,676 ft.

Rooks County: Honaker 1 Faubin, NW NW NE 12-6s-18w, in old abandoned Faubin area, dry, TD 3,155 ft.

Barnett 1 Benedict, SE SE SE 28-9s-17w, elev. 2,088 ft., dry, TD 3,659 ft., anhydrite 1,400 ft., Topeka 3,008 ft., Heebner 3,223 ft., Toronto 3,241 ft., Sooy 3,545 ft., Simpson 3,616 ft., Arbuckle 3,631 ft.

Russell County: Bay Petroleum 1 Anschutz, NW NW SE 12-14s-12w, elev. 1,737 ft., dry, TD 3,298 ft., anhydrite 595 ft., Heebner 2,792 ft., lime 2,876 ft., Lansing-Kansas City 2,899 ft., Sooy 3,202 ft., reworked Arbuckle 3,230 ft., Arbuckle 3,259 ft.

EASTERN NEBRASKA WILDCAT FAILURE

Richardson County: Chastain & Cooper 1 Mercurio, CNL NW NW 22-3n-17e, elev. 885 (?) ft., dry, TD 2,426 ft., Mississippi lime 1,998 ft., Kinderhook 2,187 ft.

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Amerada Testing Beaver Lodge Area Wildcat

DENVER.—Amerada Petroleum Corp. is now reported testing at the important Beaver Lodge, Williams County, North Dakota, wildcat after finding mud with slight amount of oil and gas from a 12-ft. zone between 11,708-20 ft. The well is 1 Iverson, CSW SW 6-155n-95w, in the center of the Williston Basin. After swabbing the above zone dry the operator has perforated between 11,675-11,706 ft. with 112 holes and is now reported swabbing for a test of this section. This wildcat had a slight show of oil on drill-stem test between 10,452-10,803 ft., and the entire lower portion of the hole is to be tested by the operator. The well topped Three Forks (Devonian) at 9,922 ft. and Jefferson (?) at 10,110 ft., and was drilled to 11,744 ft., total depth. It is located on the large Nesson dome feature, where The California Co. drilled a 10,000-ft. failure in 1938.

Water was reported in the Dakota at Phillips Petroleum Co.'s wildcat at 1 Tank Farm, NW NW SW 2-33n-74w, in the Careyhurst area, Converse County, Wyoming. The well is an important wildcat east of production in Glenrock - South Glenrock fields where Muddy and Dakota sand production has been established in recent months. Dakota was topped at 9,257 ft. and the zone was hard and tight, with some saturation reported in a 2-ft. zone. On drill-stem test with total depth at 9,303 ft. the well showed only mud and water. The operator will probably go ahead to Lakota in the wildcat.

Standard Oil Co. of California and Continental Oil Co. have had considerable difficulty with their wildcat in the Hayden Creek area, at 1 Unit, CNE NE 17-15n-59e, White Pine County, Nevada. The well was spudded December 7, 1950, and is now drilling below 3,980 ft. after having lost circulation difficulties above 1,500 ft. The well is a tight hole, with no information on tests or formation tops released by the operators. Standard of California and Continental last year drilled a deep failure 10 miles west of the new well. The well is of importance for future drilling in the Basin and Range Province for western Utah and Central Nevada.

WYOMING WILDCAT FAILURES

East Bailey, Carbon County: Sun Oil Co. 1 Govt.-Hintze, C SW SE 24-26n-89w; 6,095 ft. TD; abandoned. Fault 1,740 ft. Frontier 2,092 ft., Mowry 2,820 ft., Muddy 3,328 ft., Thermopolis 3,388 ft., Cloverly 3,480 ft., Morrison 3,536 ft., Sundance 3,802 ft., Nugget 3,962 ft., Chupwater 4,117 ft., Tenssleep 5,760 ft., Amsden 6,363 ft., Darwin 6,518 ft., Madison 6,604 ft.

North Salt Creek, Johnson County: Continental Oil Co.-Los Nietos et al 1 Federal-Parkman, NW SE NE 22-41n-79w; 2,091 ft. TD; abdn. Steele 410 ft., Sussex 960 ft., Shannon 1,396 ft., "D" sand 2,070 ft.

Lodgepole area, Weston County: R. V. Allen 1 Government, CNE NW 9-44n-66w; 6,831 ft. TD; abdn. Newcastle 6,584 ft., Dakota 6,792 ft., Fuson 6,830 ft.

COLORADO WILDCAT SUCCESS

Ignacio, La Plata County: Stanolind Oil & Gas Co. 2 Ute Indian BSW NE NW 21-33n-7w; 3,050 ft. TD; flowed 3,120 M.c.f. gas daily from Pictured Cliffs; Fruitland 2,245 ft., Pictured Cliffs 2,450 ft.

COLORADO WILDCAT FAILURE

East Wages Prospect, Yuma County: Ryan Oil Co. 1 Stella P. Clarkson, SW SW NE 14-5n-45w; 3,900 ft. TD; abdn. Niobrara

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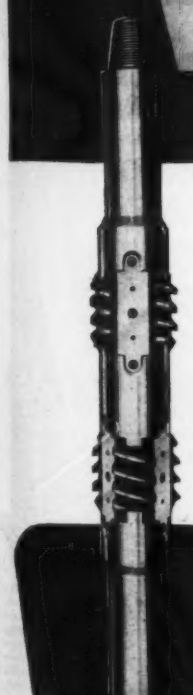

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MONTANA WILDCAT FAILURES

Reservoir Coulee, Blaine County: C. R. Bronson 1 Howard, SE SE SW 20-34n-18e; 800 ft. TD; suspended. Claggett 92 ft., Virgelle 620 ft.

Genou area, Choteau County: Hunley-Nairns & Cole 1 Rosmiller, SE SE NE 27-26n-3e, 3,700 ft. TD; suspended. Red Beds 1,427 ft., Devonian 3,175 ft.

Cedar Creek, Fallon County: Mon-O-Co. 1 Baker, NW SW SE 12-7n-60e; 1,603 ft. TD, suspended.

Pike Creek anticline, Fergus County: Ike Taylor 1 Hughes, SW NE NW 26-13n-24e; 1,565 ft. TD; completed as water well. Kootenai 86 ft., second Cat Creek 232 ft., third Cat Creek 385 ft., Morrison 508 ft., Ellis 760 ft., Amsden 926 ft.

UTAH WILDCAT FAILURE

Iron Wash, Emery County: A. K. Wilson 1 fee, SW SW SW 2-24s-13e; 1,348 ft. TD; suspended.

Permian Basin

Coring, Testing Add to Pay Section at Sinclair Well

MIDLAND.—Coring and testing in the Ellenburger at Sinclair Oil & Gas Co. 1 McElroy, Upton County discovery, has added to the proven pay section. So far, the entire section, from top at 12,102 ft. to 12,328 ft., total depth, has indicated good commercial production.

A drill-stem test from 12,212-278 ft, flowed oil with no water at an hourly rate of 143.25 bbl. Operators cored ahead to 12,328 ft., recovering vuggy dolomite having good stains and odor. A 2-hour test then between 12,282-328 ft., using 1,556 ft. of water cushion, had gas in 32 minutes; water blanket started flowing in 36 minutes and oil in 51 minutes.

It was flowed into pits for 9 minutes to clean, then turned into tanks for 1 hour through ¾-in. bottom choke. Two 30-minute gages produced 57 and 48 bbl. of 54°-gravity oil, with gas-oil ratio of 293 cu. ft. There was no water with the oil and operators were expected to core ahead and continue testing.

Last report on Cities Service and Continental Oil Co. 1-AH University, distillate discovery in southeastern Upton County, was a flow of 58 bbl. of oil and 214 bbl. of water in 24 hours.

A 7,500-ft. exploration for Coke County has been scheduled by Pan American Production Co. of Houston, as its 1 Lucille March Stone, in 46-Z-D&SERR Survey. Location is 3 miles southeast of Amerada Petroleum Corp.'s March Ranch tests drilled last year. Amerada drilled two of the wildcats to around 7,400 ft., and two were shallow tests and twins to the deep holes.

In the new Hulldale field, north of Eldorado in Schleicher County, Pan American Production Co. completed 1 H. F. Thomson as the third producer in the field and Delta Gulf completed 2 Thomson dry as the field's first failure. The new oiler is south of the discovery and the duster is a west offset.

Another Spraberry strike, or long extension to Germania field was in prospect at E. E. Fogelson, et al's 1 W. C. Houston, northeast of the field. Operators treated with Hydrafrac between 6,970-7,009 ft., after which it kicked off and made a 4-hour flow of oil which was estimated at 12-15 bbl. an hour. When the flow died, however, the flow was said to be mostly load oil. Swabbing recovered from 5-7 bbl. of oil an hour with fluid level remaining around 4,500 ft. from the surface.

WEST TEXAS (DISTRICTS 8 AND 7-C) SUCCESSFUL WILDCATS

Crane County: Cabot Carbon Co. 1 J. B. Mayberry, 3-31-H&TC, 4 mi. NW Gir-

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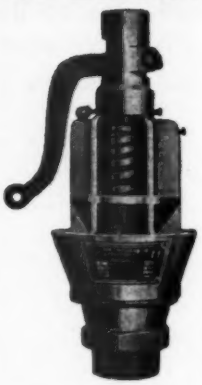

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vin, TD 5,335 ft., elev. 2,360 ft., perf. 5,118-27 ft., pumped 18 bbl. 40°-gravity oil a day.

Runnels County: C-B Drilling Co. 1 W. M. Ashton, H. Garmes Sur. 540, 3½ mi. N Ballinger, TD 2,550 ft., Swastika 2,531 ft., pumped 42 bbl. 43°-gravity oil a day.

Tom Green County: Bridwell, Perkins & Prothro 1 Julia Farr Kennemer, 6-16-H&TC, 2½ mi. NE Carlsbad, TD 7,295 ft., elev. 2,184 ft., reef 5,650 ft., pay around 5,680-5,722 ft., 42 bbl. 60°-gravity oil a day, 5,000,000 cu. ft. gas.

Bridwell et al 1 Mrs. Myrtle Mitchell, 6-16-H&TC, TD 6,096 ft., pay 5,728 ft., 2 bbl. 60°-gravity oil, 4,000,000 cu. ft. gas in 6 hr.

WEST TEXAS (DISTRICTS 8 AND 7-C) WILDCAT FAILURES

Kent County: Jake L. Hamon 1 Girard Trust Co., 59-1-H&GN, dry, TD 7,765 ft., elev. 2,163 ft., reef 6,730 ft., Mississippian 7,306 ft., Ellenburger 7,560 ft.

Mitchell County: Deep Rock Oil Corp. 1 Chester L. Jones, 61-20-Lavaca Navigation Sur., dry, TD 7,911 ft., elev. 2,311 ft., San Andres 2,078 ft., Clear Fork 3,097 ft., reef 7,718 ft.

Reagan County: Blackwood & Nichols 1 O. Daniels, 40-35-T&P, dry, TD 11,175 ft., elev. 2,687 ft., Spraberry 6,225 ft., Strawn 10,015 ft., Devonian 10,645 ft., Fusselman 10,990 ft., Ellenburger 11,105 ft.

Runnels County: Hill & Hill 1 D. J. Kirkham, Burnett CSL, 11½ mi. SW Winters, dry, TD 5,515 ft., elev. 1,891 ft., Palo Pinto 4,174 ft., Gardner 4,824-46 ft., Capps 4,440 ft.

Schleicher County: R. B. Farris 1 H. A. Thomson, 89-A-HE&WT, dry, TD 1,318 ft.

Ohio Oil Co. 1 P. K. McIntoch, 22-9-TW-&NO, dry, TD 6,930 ft., Strawn 6,310 ft., Ellenburger 6,600 ft.

Scurry County: Amerada Petroleum Corp. 1 Jap Beck, 234-3-H&TC, dry, TD 7,616 ft., elev. 2,391 ft., San Andres 1,390 ft., Strawn 7,085 ft., Caddo 7,360 ft., Mississippian 7,395 ft., Ellenburger 7,526 ft.

Sterling County: Humble Oil & Refining Co. 1-C R. T. Foster, 16-T-T&P, dry, TD 5,388 ft., elev. 2,591 ft., San Andres 1,740 ft., Clear Fork 2,380 ft., Wolfcamp 3,765 ft.

Terrell County: B. T. L. Co. 1 M. C. Goldwin, 96-1-TCRR, dry, TD 1,954 ft.

Terry County: Greenbrier Oil Co. 1 J. W. Johnson, 46-T-D&W, dry, TD 11,004 ft., elev. 3,233 ft., San Andres 4,740 ft., Spraberry 7,615 ft., Dean 8,976 ft., Wolfcamp 8,725 ft., reef 10,173 ft., Strawn 10,480 ft.

Placid Oil Co. 1 A. R. Brownfield, 60-D14- C&M, dry, TD 11,520 ft., elev. 3,423 ft., Spraberry 7,600 ft., Dean 9,056 ft.

Tom Green County: Sun Oil Co. 1 Frank J. Holik, 91-11-SPRR, dry, TD 4,857 ft., elev. 1,836 ft., Strawn 4,650 ft.

Upton County: Aldridge & Stroud 1 J. H. Shirk, 13-3-MK&T, dry, TD 2,903 ft.

SOUTHEAST NEW MEXICO

HOBBS.—Continental Oil Co. 1 Moss, 32-11s-33e, Lea County wildcat, recovered 240 ft. of slightly gas-cut mud on a 1-hour drill-stem test at 10,000-90 ft.

Sharples Oil Co. 1 Seth Alston, 17-13s-35e, was drilling ahead at 13,990 ft. in limestone and shale.

Tide Water Associated Oil Co.'s 1-PD State, east of Lovington field, was plugging back to 12,141 ft. to test the Mississippian after finding salt water in the Devonian at 12,572 ft. While drilling, the well showed some oil in the Tubb zone of the Permian, the Pennsylvanian, and the Mississippian.

The Texas Co. 1 State "AP," east of Gladiola (Devonian) field, had no shows in drill-stem testing from 10,040-10,140 ft., and was drilling ahead below 10,196 ft.

SOUTHEAST NEW MEXICO WILDCAT FAILURE

Chaves County: Shamrock Oil Corp. 1 Lightcap, 13-8s-29e, dry, TD 8,952 ft., elev. 4,063 ft., San Andres 2,430 ft., Glorietta 3,670 ft., Yeso 3,730 ft., Abo 5,970 ft., Permo-Pennsylvanian 6,870 ft., Mississippian 8,410 ft., Devonian 8,890 ft.

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California

Two Los Angeles County Wildcats Attract Attention

LOS ANGELES.—With productive limits of Castaic Junction field successfully extended ¾ mile eastward, two other wildcats in the eastern end of the Ventura Basin, Los Angeles County, are attracting more attention.

Near Newhall and a short distance west of southern Placerita production, Talisman Oil Co. has set 7-in. casing at 3,150 ft. in 1 Braille. Located in 1-3n-16w, its total depth is 3,178 ft. Prior to setting casing a 1-hour drill-stem test at 3,159-78 ft. resulted in the recovery of 1,100 ft. of oily mud and 19° crude.

At another wildcat located about ½ mile south of Oak Canyon production, in 5-4n-17w, Western Gulf Oil Co. at last reports was testing shallow shows. Drilled to 1,288 ft., oil shows were reported below 1,171 ft. The wildcat is the 2 Foley.

The Castaic Junction extensioner was the Humble Oil & Refining Co. 4 Newhall Land & Farming Co. in 19-4n-16w. Flowing through a ¼-in. bean, it produced 195 bbl. of 20.8°-gravity crude in 7 hours from 300 ft. of Mohnian sand topped at 10,306 ft.

In the San Joaquin region important developments included the establishing of production in the Carneros zone at Elk Hills and ¼-mile northwest extension to the North Antelope Hills field. At Elk Hills the deep test being drilled by Standard Oil Co. of California in 30-30s-29e flowed at the estimated daily rate of 100 to 200 bbl. of black oil and condensate on a formation test at 9,278-9,363 ft. Following the test Standard continued to core ahead and was nearing 9,400 ft. at last reports.

The North Antelope Hills extensioner was The Texas Co. 1 Effie Martin in 14-27s-19e. Located about midway between a dry hole to the northwest and the five-well pool discovered by Shell Oil Co. last August, the wildcat was completed pumping at the daily rate of 155 bbl. of 17°-gravity crude.

Other San Joaquin Valley developments included the completion of a second producer in Edison Groves field, discovered by Richfield Oil Corp. last December about 2 miles west of Race Track Hill production. In the Cuyama region Richfield also extended productive limits of Morales Canyon field one location west.

CALIFORNIA SUCCESSFUL WILDCAT

Los Angeles County, Castaic Junction field, ¾-mile east extension: Humble Oil & Refining Co. 4 N. L. & F., 19-4n-16w, flowed 670 bbl. per day, 20.8° fravity, 0.1 per cent cut, 16/64-in. bean from Mohnian sand at 10,306-10,609 ft., TD 10,651 ft., elev. 1,295 ft.

CALIFORNIA UNSUCCESSFUL WILDCATS

Fresno County, Kerman area: Honolulu Oil Corp. 1 Ponte, 24-13s-16e, dry, botomed in Cretaceous sands, Zilch 3,391 ft., TD 4,854 ft., elev. 198 ft.

Kern County, McDonald Anticline area: Macson Oil Co. 34-10 Still, 10-28s-19e, dry, base Devil Water top Gould shale 935 ft., Buttonbed 1,215 ft., lower Santos shale 1,450 ft., Phacoides reef 1,630 ft., top Point of Rocks 1,659 ft., TD 1,767 ft., elev. 1,325 ft.

Tejon Hills area: Cliff E. Zilgitt 2 K, 14-11n-18w, dry, bottomed in gray sand, TD 1,067 ft., elev. 1,304 ft.

Madera County, Chowchilla area: Los Nietos Co. 55-31 Southern Realty, 31-9s-14e, dry, TD 3,559 ft., elev. 141 ft.

Napa County, Steele Canyon area: Western Gulf Oil Co. 1 F. G. Johnson, 28-8n-3w, dry, TD 6,009 ft., elev. 500 ft.

San Luis Obispo County, Cholame area: Chas. Schmidt 43-16 Jack, 16-25s-16e, dry, bottomed in Cretaceous, top 3,089 ft., TD 3,157 ft., elev. 1,450 ft.

Santa Barbara County, Tinaquaic Rancho-Foxen Canyon area: Tide Water Asso-

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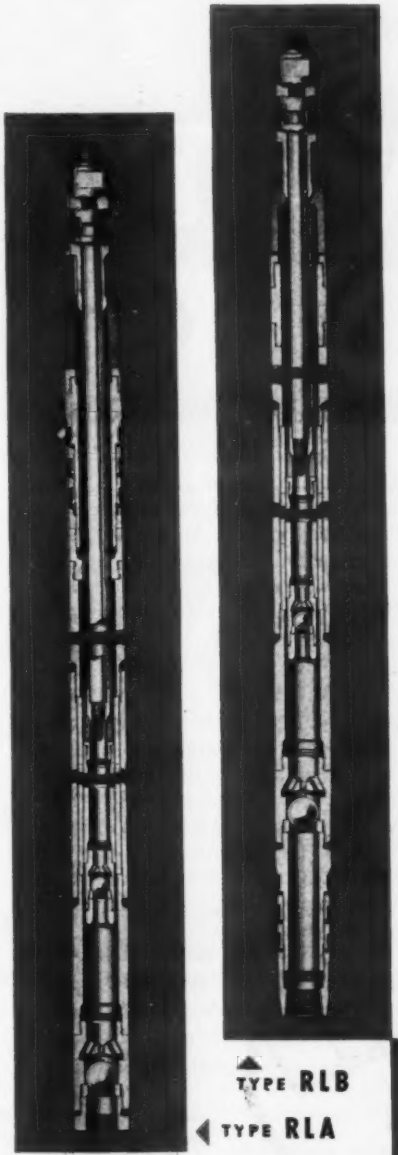

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ciated Oil Co. 1 Tinaquaic, 36-9n-32w, dry, TD 4,958 ft., elev. 887 ft.

Tulare County, Visalia area: Ebonoro Oil Co. 1 McCarrell, 3-17s-25e, dry, TD 492 ft., elev. 350 ft.

Ventura County, Cuyama Valley - Quatal Canyon area: Richfield Oil Corp. A-1 Gillberg, 31-9n-23w, dry, TD 2,456 ft., elev. 3,728 ft.

Sisar-Silverthread area: Jergins Oil Co. 1 Hillside, 8-4n-21w, dry, TD 8,868 ft., elev. 1,462 ft.

Oklahoma

Swabbing Yields Oil in Roger Mills Wildcat

W A. DELANEY, JR., 1 Oscar Ewton, C SE SW 17-11n-23w, prospective discovery well southwest of Berlin in southern Roger Mills County, near the Beckham County line, swabbed at the rate of 1½ bbl. of net oil per hour while cleaning out after reacidizing through casing perforations at 10,760-93 ft. In earlier efforts to swab the well from the same perforation interval, considerable trouble was experienced with mud breaking in and killing the flow. During one 2-hour period before mudding up, the well swabbed an estimated 10 bbl. per hour. Since earlier swabbing attempts, the producing interval has been reperforated with an additional 72 holes. First perforations totaled 96. The interval now being tested is one of three prospective granite wash pay zones encountered by the well. The other two, one at 9,157-9,212 ft. and the other below 11,000 ft., remain to be tested. Total depth is 11,051 ft. with casing cemented at 11,040 ft.

Testing also is getting under way at Carter Oil Co.'s prospective discovery well, 1 Garrett, SE SE SE 32-11n-25w, 13 miles to the southwest in northwestern Beckham County. Since this well's attempted blowout while drilling at 10,297 ft., the hole has been deepened 1 ft. to 10,298 ft. and 7-in. casing run to 10,295 ft. At last report, casing had been perforated at 10,250-51 ft., and a packer drill-stem test run. In this test gas-cut load oil and mud was recovered with a trace of new oil.

A promising Bartlesville sand pool appears to have been found in northeastern Kay County, near the Kansas line. The prospective discovery well is Dean Witter 1 Widener, SE NW NW 20-29w-3e. It topped the Bartlesville at 3,214 ft., and penetrated it to 3,222 ft., showing good saturation. A drill-stem test from 3,217 ft. to bottom had gas within 3 minutes and started to flow clean 42° oil within 37 minutes after the tester was opened. Tester was closed when oil appeared but oil continued to flow for another 15 minutes. Flow rate was estimated at 25 bbl. per hour.

Gene Goff 1 Bailey, SE SE NE 20-4n-1w, a mile northwest of the West Pauls Valley pool, Garvin County, showed for a good producer in lower Pennsylvanian detrital zone, topped at 4,647 ft. West Pauls Valley pool produces from the Bromide sand, a much deeper pay.

OKLAHOMA SUCCESSFUL WILDCATS

Carter County: Kerr-McGee 1 Williams, NW NW NW 11-1s-3w, elev. 908 ft., 5,000,000 cu. ft. of gas per day from Goodwin (Springer) sand at 4,608-78 ft., TD 5,078 ft., Deese 1,975 ft., Humphrey 3,725 ft., Simpson 4,015 ft., sand 4,600 ft.

Garvin County: Osborn 1 Dimmitt, C SE NW 35-2n-2w, elev. 984 ft., flowed 164 bbl. of oil from Gibson at 6,870-78 ft. and flowed 170 bbl. of distillate from Hart at 7,026-46 ft., TD 7,090 ft.

Osage County: G. F. Martin 3 Osage, SW NW SE 35-21n-11e, elev. 781 ft., pumped 11 bbl. of oil per day from Hominy at 2,045-49 ft., TD 2,102 ft., Big lime 803 ft., Oswego 963 ft., lime 1,268 ft., Bartlesville 1,370 ft., Burgess 1,659 ft., Woodford 1,993 ft.

Payne County: Amerada 1 White, NW NW SE 4-19n-3e, elev. 989 ft., pumped 11 bbl. of oil per day from Red Fork at 3,991-

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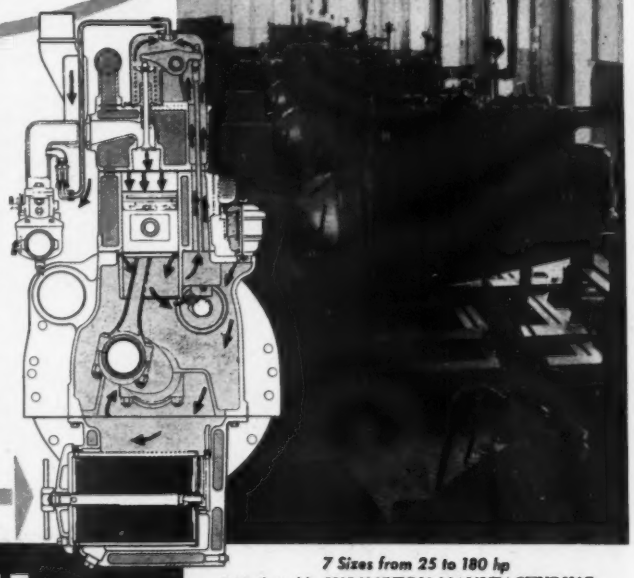

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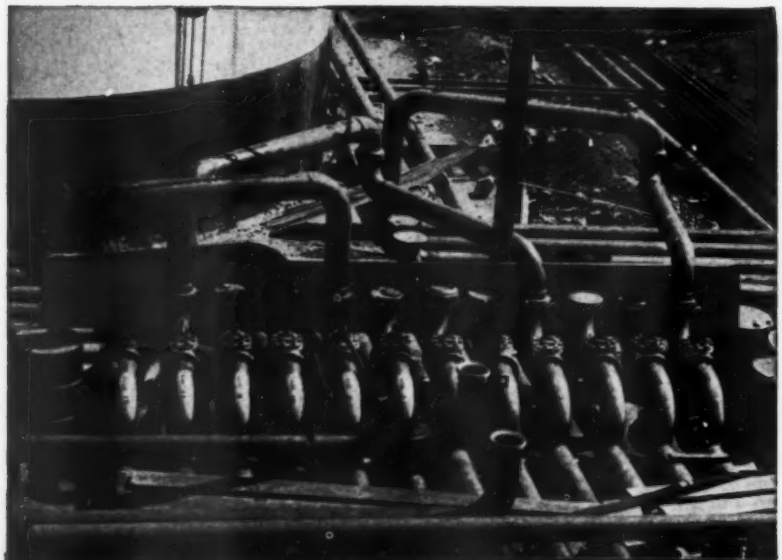

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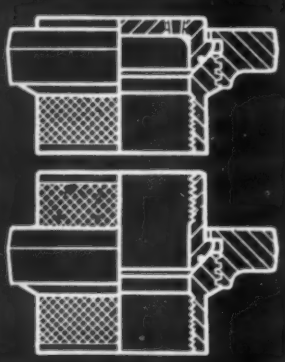

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OKLAHOMA WILDCAT FAILURES

Beckham County: H. B. & G. Drilling 1 Hawkins, NE NE NE 25-9n-23w, elev. 1,797 ft., dry, TD 3,013 ft., dolomite 2,545 ft., show of gas 2,583 ft., sandy shale 2,710 ft., hard sandy lime 2,729 ft., pyritic lime 2,730 ft., sandy lime 2,943 ft., granite wash 2,960 ft., shale 2,997 ft., hard lime 3,002 ft., granite wash 3,008 ft.

Bryan County: K. S. & W. Drilling 1 Gilbert, SE NW SW 25-8s-7e, dry, TD 1,200 ft., no tops reported.

Carter County: Mul-Berry Oil Co. 1 Smith, NE SW NE 30-5s-1e, dry, TD 3,355 ft., elev. 876 ft., lower Anadarche 1,338 ft., upper Bayou 1,813 ft., Chubbee 2,327 ft., Norris 2,725 ft., Lone Grove 3,094 ft.

Grant County: Imperial Petroleum Co. 1 Atkinson, NW NW SE 18-29n-3w, elev. 1,100 ft., dry, TD 4,873 ft., Pawhuska 2,307 ft., Oread 2,719 ft., Haskell 3,085 ft., Tonkawa 3,145 ft., Layton 3,589 ft., Big lime 3,692 ft., Oswego 3,826 ft., Mississippi chat 4,379 ft., Mississippi lime 4,458 ft., Woodford 4,738 ft., Viola 4,814 ft., Simpson 4,823 ft.

Harper County: H. E. R. Drilling et al 1 Harrison-Selman, C NE SE 33-26n-20w, elev. 1,791 ft., dry, TD 7,007 ft., Krider 2,760 ft., Winfield 2,818 ft., base Wreford 3,175 ft., Lovell 4,909 ft., Tonkawa sand 5,286 ft., Checkerboard 5,819 ft., Big lime 5,910 ft., Oswego 5,980 ft., Cherokee 6,112 ft., Verdigris 6,166 ft., Inola 6,304 ft., Morrow 6,406 ft., Chester 6,463 ft., Mississippi lime 6,907 ft.

Love County: The Texas Co. et al 1 Jackson, NW SW SW 8-8s-2w, elev. 776 ft., dry, TD 7,201 ft., Hoxbar 2,090 ft., Daube lime 2,143 ft., Anadarche 2,622 ft., Deese 5,041 ft., Dornick Hills 5,845 ft., Arbuckle 6,754 ft.

Noble County: Woods Drilling et al 1 Nichols, SE SE SE 23-21n-1e, elev. 989 ft., dry, TD 4,554 ft., Tonkawa 1,950 ft., Avant 2,765 ft., Osage-Layton 2,960 ft., lower Layton 3,221 ft., Checkerboard 3,495 ft., Big lime-Oswego 3,656 ft., Prue 3,845 ft., Verdigris 3,894 ft., lower Skinner 3,983 ft., Red Fork 4,029 ft., Bartlesville 4,082 ft., Mississippi lime 4,251 ft., Woodford 4,394 ft., Viola 4,442 ft., Wilcox 4,504 ft., second Wilcox 4,532 ft.

Osage County: Fordee Rhodes 3 Osage, SE SE SW 23-22n-8e, elev. 990 ft., dry, TD 3,022 ft., Avant 1,091 ft., Hogshooter 1,392 ft., Layton 1,419 ft., Jones 1,689 ft., conglomerate 1,804 ft., Big lime 1,950 ft., Oswego 2,096 ft., Mississippi lime 2,611 ft., Hominy 2,872 ft., Arbuckle 2,971 ft.

Pawnee County: T. N. Berry Co. 1 Waters, NE SW SE 3-21n-5e, elev. 938 ft., dry, TD 3,200 ft., Checkerboard 2,500 ft., conglomerate 2,600 ft., Oswego 2,783 ft., Verdigris 2,900 ft., lower Skinner 3,080 ft., Red Fork 3,126 ft.

Payne County: Elson, Kaye et al 1 Hesser, NE NW NE 21-20n-3e, elev. 987 ft., dry, TD 4,201 ft., Hogshooter 3,008 ft., Checkerboard 3,360 ft., conglomerate 3,505 ft., Oswego 3,540 ft., Verdigris 3,793 ft., Skinner 3,890 ft., lime 3,931 ft., Red Fork 3,962 ft., Inola 4,115 ft., Bartlesville 4,131 ft., Mississippi lime 4,190 ft.

H. E. R. Drilling et al 1 Perterka, NE NE NE 24-20n-2e, elev. 986 ft., dry, TD 4,710 ft., conglomerate 3,650 ft., Mississippi lime 4,310 ft., Misener 4,578 ft., Woodford 4,533 ft., Viola 4,591 ft., Wilcox 4,658 ft., second Wilcox 4,686 ft.

Pontotoc County: Jones-Shelburne 1 Needham, SE SE SW 13-4n-5e, elev. 1,009 ft., dry, TD 2,845 ft., Calvin 1,166 ft., Cromwell 1,393 ft., Caney 1,580 ft., Hunton 2,530 ft., Chimney Hill 2,577 ft., Sylvan 2,605 ft., Viola 2,746 ft.

C & D Drilling 1 Busby, C NW 9-4n-8e, elev. 948 ft., dry, TD 2,108 ft., Senora shale 285 ft., Thurman 365 ft., Boggy 785 ft., McAlester 1,730 ft., Atoka 2,045 ft.

Stephens County: L. A. Edwards, Jr. 1 Freeman "A," NW NW NW 18-3s-5w, dry, TD 2,412 ft., Loco lime 1,125 ft., lower Canyon 1,983 ft., Arbuckle detrital 2,231 ft., Arbuckle 2,255 ft.

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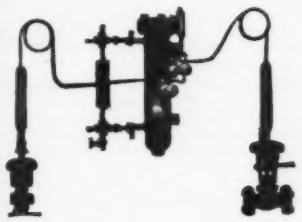

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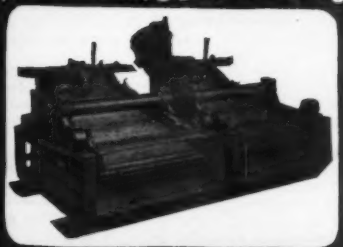

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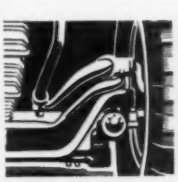

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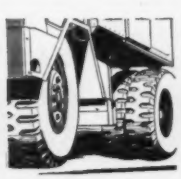

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Standco Brake Lining Co.
HOUSTON

South Louisiana

Big Island Field Outpost Recovers 1,820 Ft. of Oil

NEW ORLEANS.—At a west outpost to Big Island field, Rapides Parish, Arthur Silberman recovered 1,820 ft. of oil and 40 ft. of water on drill-stem test in 1 Beaubeouf, CNE SE 4-4n-3e. Operator cored sand section from 4,750 to 5,572 ft., encountering Wilcox pay zone from 5,542-55 ft. Drill-stem test was run at 5,542-72 ft. with too lopen 15 minutes. Hole is at total depth of 5,572 ft. and operator cemented 5-in. oil string on bottom.

In the Four League Bay area of Terrebonne Parish, Humble Oil & Refining Co. is possibly opening a new oil field from below 13,000 ft. Few details have been released by the company; however, the well, 1 State Lease 1869, Four League Bay, was perforated at 13,742-49 ft. and 13,759-65 ft. and squeezed. New perforations were slated to be made for production at 13,004-12 ft. Hole is bottomed at 14,395 ft.

A new producing oil sand has been discovered in Lottie field of Pointe Coupee Parish. The Texas Co. 1 State-Reno, et al, Unit 1, 37-5s-8e, flowed 157 bbl. of 48°-gravity oil daily through perforations at 10,420-36 ft. Flow was gaged through a 7½/64-in. choke, and tubing pressure was 1,900 psi. This opens up an entirely new producing area for Lottie field, which has been a gas producer.

SOUTH LOUISIANA SUCCESSFUL WILDCATS

Livingston Parish: Oil discovery, Lake Maurepas—Roeser & Pendleton 1 State Lease 1,468, TD 10,270 ft., perf. 9,815-50 ft., IP: 320 bbl. oil per day, 10/64-in. choke, TP 1,400 psi., 47.8° gravity.

SOUTH LOUISIANA WILDCAT FAILURES

Avoyelles Parish: Lamar Hunt Trust Estate 1 Max M. Merrick, 13-1s-4e, dry, TD 11,582 ft.

East Baton Rouge Parish: Sohio Petroleum Co. and Kemp Drilling Co. 1 M. F. Easterly, 50-8s-2e, dry, TD 10,748 ft.

Lafourche Parish: The California Co. 1 E. P. Brady, et al, Unit 1, Twp. 16s-22e, dry, TD 10,604 ft.

Rapides Parish: Floyd L. Karsten 1 F. L. Swann, 37-4n-4w, dry, TD 7,512 ft.

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Mississippi

Jones County Wildcat Shows Heavy Oil on Test

JACKSON.—On the Sandersville prospect in Jones County, Smith County Oil Co. 1 Mrs. M. J. Sanders, wildcat, NW SW SW 32-10n-10w, encountered top of City Bank zone of the Eutaw at 5,349 ft. A core was cut at 5,350-60 ft. with recovery being 10 in. of porous sand saturated with heavy black oil and 7 ft. 10 in. of shaly sand with slight show of oil. Operator ran a drill-stem test at 5,352½-60 ft., using ¼-in. top and ½-in. bottom chokes and no water cushion. Tool was left open for 1 hour with recovery being 25 ft. of drilling mud cut with heavy black oil with a trace of salt water.

This wildcat is located in an area where Union Sulphur Co. drilled two wildcats, both of which produced a small amount of heavy black oil before being abandoned as noncommercial.

On the west side of Tinsley field in Yazoo County, Union Producing Co.-Jones-O'Brien 1 Logan, 23-10n-3w. Smackover venture, is still coring in the Buckner. Latest core was cut at 13,515-65 ft. with no shows. The well is bottomed at 13,565 ft.

At Mississippi's other Smackover operations, Continental Oil Co. 1 John R. Cam-

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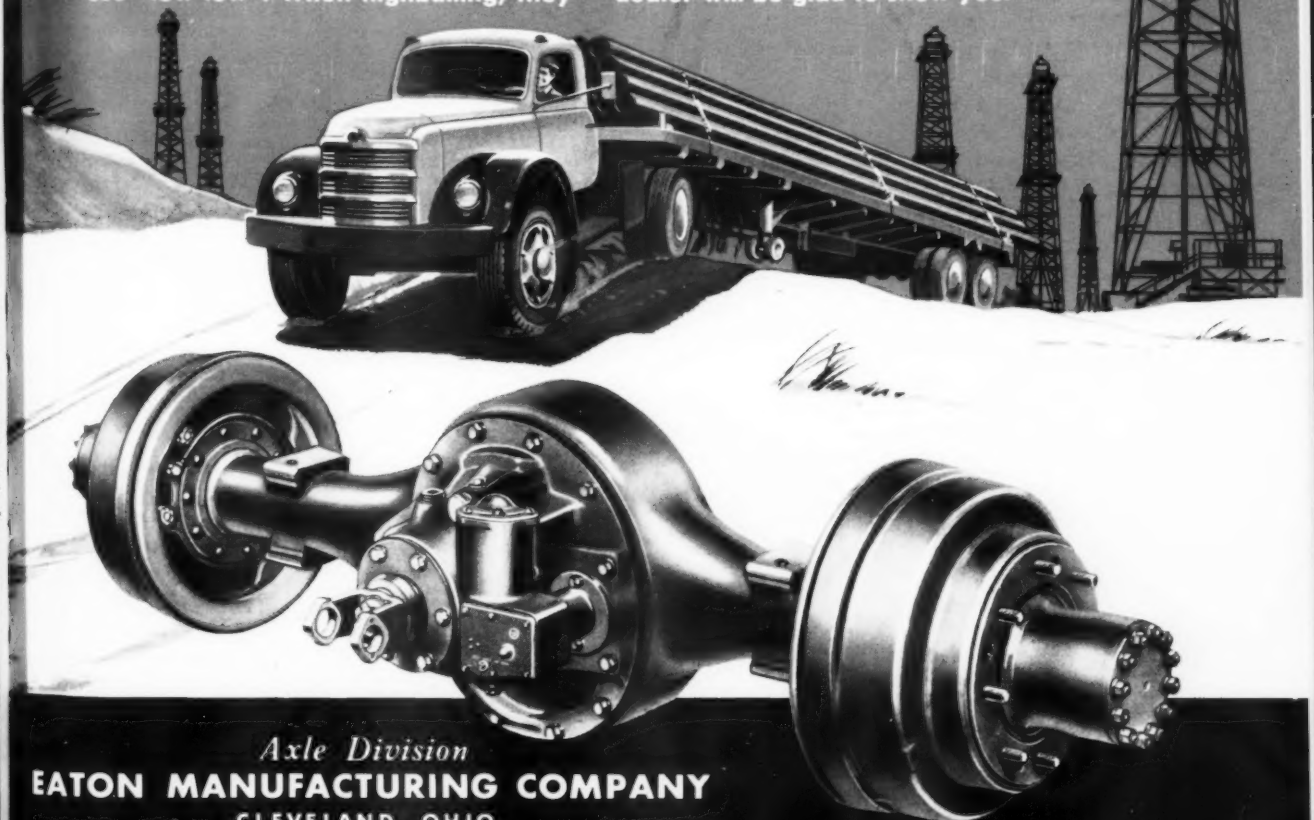

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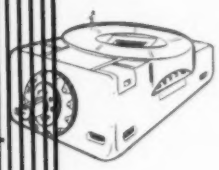

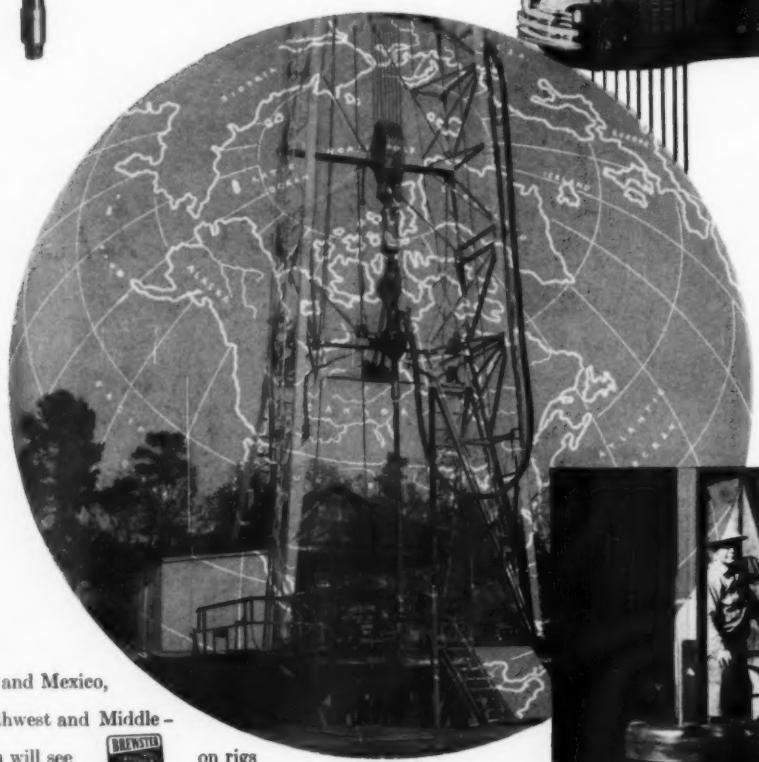

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SINCE 1910—Manufacturers of drilling equipment

eron, 36-10n-1e, Madison County, is reported drilling at 13,635 ft. in Cotton Valley.

The other, Honolulu Oil Corp. 1 Board of Supervisors, 16-5n-9w, Scott County, is drilling ahead at 12,084 ft. after running electrical log to 12,036 ft. This well was scheduled to go to 12,000 ft., and is now being drilled on a day-to-day basis, so it is questionable whether the well will be carried to the Smackover.

Carter Oil Co. 1 G. L. Crawford, 7-7n-2e, Madison County wildcat, is fishing for drill pipe at 4,290 ft. This well cored a 9-ft. section with show and recovered 23°-gravity oil on two drill-stem tests run in the Gas Rock section at 3,708-15 ft. and 3,706-25 ft. The well will be drilled to contract depth of 6,500 ft.

MISSISSIPPI WILDCAT FAILURES

Attala County: Justiss-Mears Oil Co., et al, 1 Bingham, 4-16n-6e, dry, TD 2,308 ft.
Franklin County: Stanolind Oil & Gas Co. 1 U. S. A., 22-7n-5e, dry, TD 10,830 ft.
Wilkinson County: Kemp Drilling Co. 1 U.S.A., 27-4n-1w, dry, TD 7,519 ft.

Appalachian-Ohio

Two Gas Wells Completed in Garrett County, Maryland

PITTSBURGH.—Two gas wells have been completed in the Mountain Lake Park section of Garrett County, Maryland, and location has been staked for another test.

The completed wells are Columbian Carbon Co. 1-GW-1504 Joni J. Miller, elevation 2,463 ft., which gaged 363,000 cu. ft. of gas after acidizing, in Oriskany sand at 3,943 ft.; and George L. Yaste 1 Grimes, elevation 2,421 ft., which showed 348,000 cu. ft. of gas on open flow after acidizing in Oriskany at 3,573-90 ft. The new location is Eberly & Johnson 1 Wm. White.

A good gas well was reported in the Union district of Jackson County, West Virginia. Hope Natural Gas Co. 9480 Maggie Baier showed 3,480,000 cu. ft. of gas in Brown shale at total depth of 3,763 ft. In the Clover district of Tucker County, Hope Natural 9384 Herbert Shaffer is drilling at 664 ft.; in Portland district of Preston County, the company's 9636 Margaret C. Kraus is building rig; and 9637, on the same farm, rig is being moved in.

MARYLAND SUCCESSFUL WILDCATS

Garrett County: Columbian Carbon Co. 1-GW-1504 Joni J. Miller, elev. 2,463 ft., 363,000 cu. ft. of gas, after acidizing. lime 3,814 ft., Oriskany sand 3,943 ft., TD 4,400 ft.

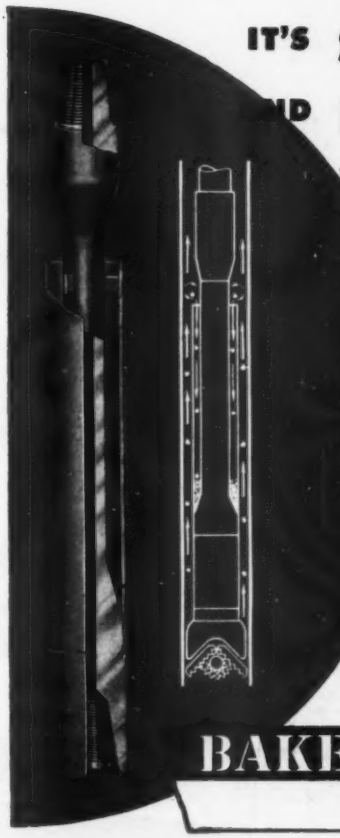
George L. Yaste 1 Grimes, elev. 2,421 ft., 348,000 cu. ft. of gas, after acidizing, chert 3,387-3,487 ft., gas 3,407 ft., Oriskany sand 3,510-3,631 ft., gas 3,573-90 ft., TD 3,651 ft.

OHIO

COLUMBUS.—Another good well was completed in old Burbank pool. Ditch & Gerig 3 Anna Parmenter, Section 18, Canaan Township, Wayne County, topped the Newburg at 2,875 ft., and at 2,924 ft. had 1,350,000 cu. ft. of gas, natural.

In New Castle pool, Oxford Oil Co. 2 J. C. Staats, 3rd quarter, New Castle Township, Coshocton County, found the Clinton at 3,140-57 ft. and 3,161-93 ft., with a good show of oil. After a 90-qt. shot, the well made 55 bbl. in 24 hours. In Perry Township, Mickley & Workman 3 Mauria Hawk, Section 15, gaged 500,000 cu. ft. of gas, natural, with a showing of oil. After shot, the well made 25 bbl. of oil plus 500,000 cu. ft. of gas in 24 hours.

Ohio Fuel Co. 2 H. W. Dupler, Section 33, Hopewell Township, Perry County, gaged 520,000 cu. ft. of gas, natural. The Clinton sand was logged at 2,912-44 ft. Ideal Natural Gas Co. 1 Maxwell, Section 7, Monroe Township, wildcat, found the Clinton at 3,650-93 ft. with a small show of oil and gas. The Medina sand at 3,765 ft. was dry, and the test was plugged.



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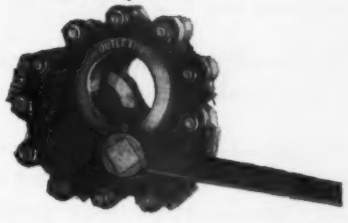

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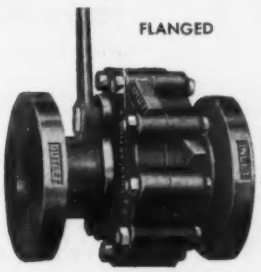

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North Central Texas

Lone Star Wildcat Looms As Bend Conglomerate Hit

WICHITA FALLS.—Lone Star Producing Co. 1 A. J. Yates, J. Gunter Survey, was a prospective Bend conglomerate discovery, based on a drill-stem test from 5,357-69 ft. Gas surfaced in 1 hour and 45 minutes, and at the end of 3 hours recovery was 225 ft. of heavily oil-cut mud plus some free oil. It was drilled ahead to 5,631 ft. with no further shows, then set casing to 5,451 ft. for testing. Location is 1½ miles southwest of the Riggs conglomerate discovery of last year, which has remained a one-well development.

In Young County, Warren Oil Corp. completed 1 O. D. Swanzy as a Mississippian discovery, ½ mile east of the town of Olney. Completion potential was 154 bbl. of 42°-gravity oil a day through 16/64-in. choke, from perforations at 4,900-18 ft. Nearest Mississippian production is the Gabby field, 2½ miles to the northwest. Warren's 1 A. C. Deats, Kellum Survey, southeast of Graham was reported dry at 4,765 ft.

New Strawn sand production for east-central Archer County was in prospect at W. G. Rogers 1 K. Kinder, Clark & Plumb Survey, and east of the King pool. Top of the Strawn was 3,723 ft. A test to 3,732 ft. showed gas in 15 minutes and 1½ hours recovery was 1,200 ft. of 40°-gravity oil, 280 ft. of oil-cut mud and 60 ft. of salt water. The pipe unloaded at intervals while being pulled. It was drilled ahead to 3,804 ft. and cased to 3,788 ft.

In Fisher County, General Crude Oil Co. 1 David A. Ulmer, northwest of Hamlin, ran casing to 5,125 ft. for completion tests in open hole to 5,140 ft. Drill-stem test in the Strawn, topped at 5,122 ft., had gas in 6 minutes and oil in 1 hour and 25 minutes. It made a 20-minute flow, which was not gaged. Recovery was 2,570 ft. of oil and 130 ft. of drilling mud.

In Montague County, Bend conglomerate production was indicated at Konrad Sztykgold 2 Minnie Littell, G. E. Givens Survey, southeast of Mallard. A 1-hour drill-stem test from 6,741-49 ft. had gas in 16 minutes and recovered 100 ft. of free oil, 350 ft. of oil-cut mud and 40 ft. of salt water.

In Throckmorton County, Cities Service Oil Co. and Sinclair Oil & Gas Co. 1-170 SMS Ranch was made a dual producer from both the upper and lower Caddo zones. The well was a discovery in 1950, flowing 651 bbl. of oil a day from perforations at 4,903-12 ft. Production was said to have decreased to the pumping stage and operators reperforated from 4,733-53 ft. and recompleted from both zones. New potential was 197 bbl. of 40°-gravity oil, flowing on both sets of perforations.

NORTH CENTRAL TEXAS (DISTRICTS 9 AND 7-B) SUCCESSFUL WILDCATS

Archer County: Wayne Freeman, Jr. 1 J. M. Bloodworth, M. Cartwright Sur., 5 mi. SW Anarene TD 5,144 ft., perf. Mississippian 5,118-36 ft., flowed 924 bbl. oil a day, ½-in. choke, TP 200 psi.

McElroy Ranch Co. 1 L. F. Wilson, ANCL Sur., 3 mi. NE Geraldine, TD 3,820 ft., pay 3,809 ft., pumped 51 bbl. 42°-gravity oil a day, GOR 425 cu. ft.

Jones County: Taubert Drilling Co. 1 J. W. Tiner, S. M. Reynolds Sur., 3 mi. SW Noodle, TD 4,311 ft., elev. 1,852 ft., perf. Noodle Creek 2,478-88 ft., pumped 85 bbl. 39°-gravity oil a day, GOR 250 cu. ft.

Montague County: Bryant & Lipscomb 1 C. C. Lacy, Blk. 132, Belcher Subd., 5½ mi. SE Belcherville, TD 5,867 ft., conglomerate pay 5,849 ft., flowed 132 bbl. 40°-gravity oil a day, 20/64-in. choke, TP 120 psi., GOR 700 cu. ft.

Stephens County: Gilchrist Drilling Co. 1-A Swenson Ranch, 37-5-T&P, 6 mi. SE Breckenridge, TD 2,258 ft., elev. 1,265 ft., pay 1,922 ft., pumped 40 bbl. 40°-gravity oil a day.

Bob Sunshine 1 B. C. McNabb, 67-4-T&P, 16 mi. NW Strawn, TD 1,884 ft., elev. 1,455 ft., pay 1,880 ft., flowed 161 bbl. 40°-gravity oil a day, open tubing, TP 25 psi.

Stonewall County: Cities Service Co. 1 Baitz, Sec. 27, BBB&C Sur., 2½ mi. E Old Glory, TD 6,130 ft., elev. 1,626 ft., perf. conglomerate 6,005-29 ft., pumped 24 bbl. 41°-gravity oil a day.

Wise County: Kingwood Oil Co. 1 J. H. Peel, A. Hargus Sur., 1½ mi. N Springtown, TD 3,938 ft., elev. 922 ft., Caddo 3,451 ft., pay 3,792 ft., pumped 174 bbl. 39°-gravity oil a day, GOR 314 cu. ft.

NORTH CENTRAL TEXAS (DISTRICTS 9 AND 7-B) WILDCAT FAILURES

Archer County: H. L. Hollyfield 1 E. N. Phillips, Thos. McCoy Sur., 11 mi. SE Archer City, dry, TD 1,224 ft.

G. E. Kadane & Sons 1-N W. C. Frey, Palo Pinto CSL, 1 mi. NE Dundee, dry, TD 5,018 ft.

Needl & Hood Drilling Co. 1-F L. F. Wilson, 4-3-ATNCL Sur., 6½ mi. SE Mankins, dry, TD 1,590 ft.

Baylor County: Bridwell Oil Co. 1 A. F. Wirz, T&NO Sur., 2½ mi. NE Seymour, dry, TD 5,456 ft.

Mid-Continent Petroleum Corp. et al 1 Daisy Smith, T&NO Sur., 4 mi. NE Seymour, dry, TD 5,741 ft., Gunsight 2,335 ft., Bunger 2,610 ft., Canyon 2,846 ft., Caddo 5,349 ft., Mississippian 5,602 ft.

Tres Oil Co. 1 E. W. Hunt, J. Garner Sur., 4 mi. E Goree, dry, TD 1,632 ft.

Clay County: Jack Grace Production Co. 1-B Hapgood, J. Crawford Sur., 6 mi. SE Henrietta, dry, TD 6,590 ft., Caddo 5,948 ft.

Coleman County: Creslenn Oil Co. 1 Greenway, David A. Murdock Sur. 738, 2¼ mi. E Coleman, dry, TD 2,370 ft.

G. F. Lebus, Jr. and Roy H. Lebus 3 A. E. Jones, T&NO Sur., 4 mi. SW Novice, dry, TD 3,549 ft.

Cooke County: R. A. King & Sons 1 J. C.

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Pybas, E. Mora Sur., 5 mi. NW Sivells Bend, dry, TD 7,515 ft.

Eastland County: Bert Fields 1 J. H. Kendricks, 46-4-H&TC, 5 mi. E Cisco, dry, TD 3,677 ft.

Kenilworth Oil Co. 1 L. C. Downtain, John House Sur., ½ mi. E Eastland, dry, TD 3,103 ft., elev. 1,437 ft., Caddo 2,926 ft.

Woodley Petroleum Co. 1 Hamor est., T&NO Sur. 1, 5 mi. W Ranger, dry, TD 3,760 ft., elev. 1,545 ft., Strawn 1,984-92 ft.

Haskell County: E. K. & E. M. Burt 1 O. A. Dunnam, W. J. Thornton Sur., 2½ mi. SW Weinert, dry, TD 5,134 ft.

Jack County: Benson-Montin, Inc. 1 M. E. Roper, Navarro CSL, 3 mi. SW Jacksboro, dry, TD 5,685 ft.

T. M. Weatherred 1 Ellis, Blk. 6, James W. Williams Sur., 4 mi. S Antelope, dry, TD 570 ft.

Jones County: DeSoto Oil Co. 1 R. A. Smith, 2-17-T&P, 2 mi. SE Truby, dry, TD 3,650 ft., elev. 1,668 ft., reef 3,278 ft.

Ralph Harper 1 J. J. Crawford, BBB&C Sur., 3 mi. S Tuxedo, dry, TD 2,957 ft.

Joe H. Staley 1 Guitar trust, G. Martinez Sur., 2 mi. N Hawley, dry, TD 2,252 ft.

Stonewall County: Kewanee Oil Co. 1 Hart, 270-D-H&TD, 10 mi. SW Aspermont, dry, TD 6,485 ft., elev. 1,387 ft., Cisco 3,540 ft., Canyon sand 4,760 ft., Strawn 5,693 ft., Ellenburger 6,473 ft.

W. C. McBee 1 Phumphrey heirs, 11-C-AB&M, 10 mi. NE Aspermont, dry, TD 6,095 ft., elev. 1,555 ft., Strawn 4,970 ft., Caddo 5,730 ft., conglomerate 5,834 ft.

Throckmorton County: Cherry & Haesemyer et al 1 A. B. Callahan, TE&L Sur., 1 mi. SW Woodson, dry, TD 3,320 ft.

Wilbarger County: Lester Miller Drilling Co. 1 W. T. Waggoner, 3-4-H&TC, 10 mi. SW Electra, dry, TD 2,508 ft.

Michigan

Traverse Prospects Tested At Oceana County Wildcat

MOUNT PLEASANT.—Cable tool cleanout should be completed soon at the Gulf Refining Co. 1 Ruckel, SE SW NW 18-14n-18w, Benona Township, Oceana County. The well is a potential new west state oil discovery, which showed 400 ft. of free oil, gas, mud-cut oil, drilling mud, and salt water on a drill-stem test of the Traverse. Top of the Traverse lime was reported at 1,732 ft. Oil pay was logged from 1,735-63 ft. with bottom 2 ft. showing salt water. This wildcat is being completed in the Traverse zone commonly referred to as the Stony Lake horizon—a pay discovered and being produced by Carter Oil Co. in the Stony Lake field, Claybanks Township, Oceana County, about 6 miles to the south.

In the Skeels Dundee-dolomite area, Sherman Township, Gladwin County, Don Rayburn completed his third dry hole offsetting the lone producer in the pool. This failure was the fourth close-in or offset test to fail. Another dry hole was drilled by Sun Oil Co. Rayburn's 3 Cassiday was a northwest 10-acre offset to the 1 Cassiday, flowing well. Dundee limestone top was logged in this test at 3,352 ft. Hole was cored to total depth of 3,922 ft. A drill-stem test was run with packer set at 3,851 ft., with hole bottomed out at that time at 3,872 ft. Recovery showed 20 ft. of drilling mud on a 2-hour test.

Sun Oil Co. was moving rotary tools to the 2 Smith, SE SE SW 30-20n-2w, for the next venture in the Skeels area. Sun's 2 Smith is the direct west offset to the 1 Cassiday producer, and the direct north offset to Sun's first test, which was dry.

MICHIGAN SUCCESSFUL WILDCAT

Mecosta County, Green Township: Mercer Oil Co., Inc., and Smith Petroleum Co. 1 Soper, NW SW SW 13-16n-10w, Dundee 3,531 ft., 220,000 cu. ft. of gas from

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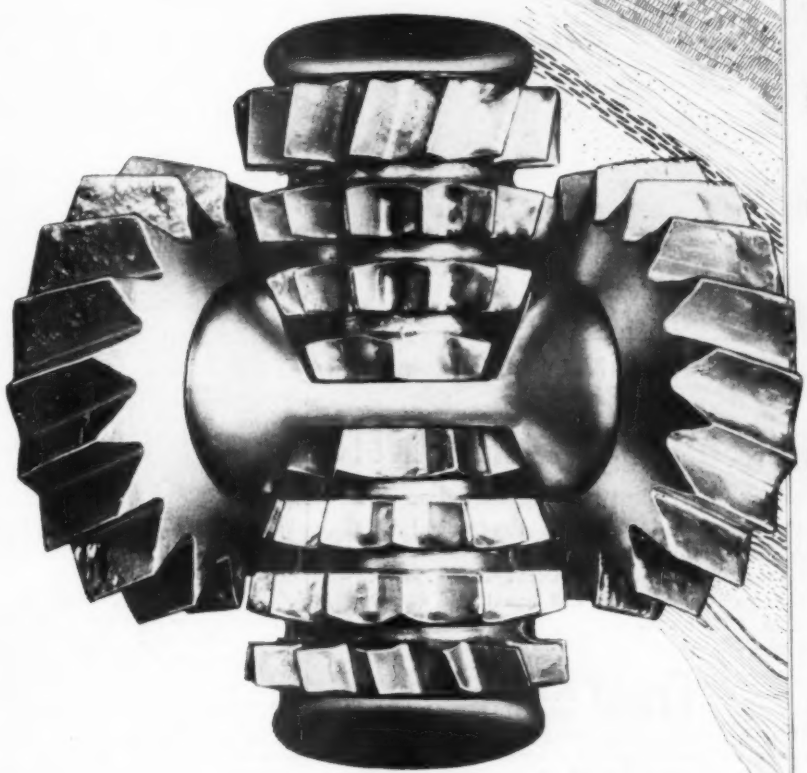

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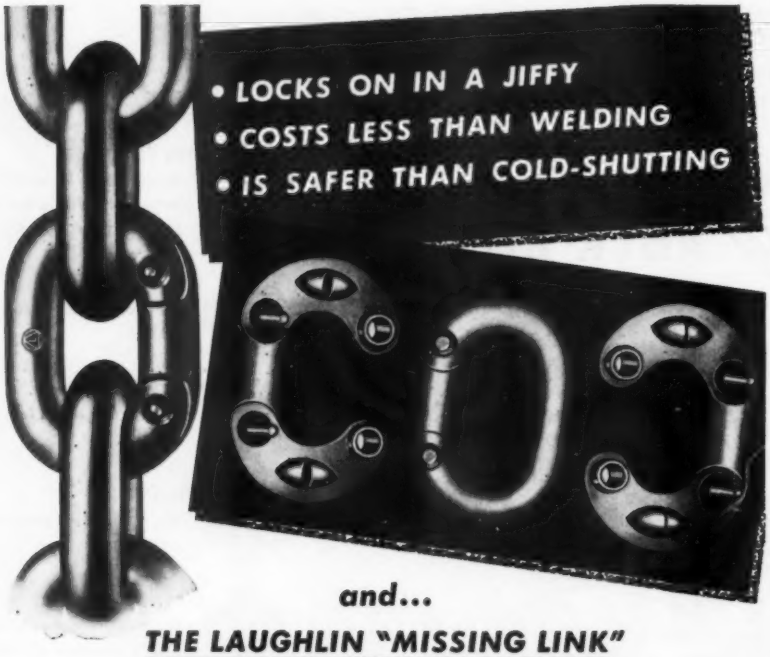

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MICHIGAN WILDCAT FAILURES

Allegan County, Ganges Township: W. C. Vandenberg, Jr., 1 Mann, SE NE NE 2-2n-16w, Traverse 1,363 ft., dry, TD 1,384 ft.

Ford Oil Co. 1 Wing, SW SE SE 21-2n-16w, Traverse 1,268 ft., dry, TD 1,277 ft.

Valley Township: Rex Oil & Gas Co. 1 Balgoyne et al., NW SW NE 12-2n-14w, Traverse 1,496 ft., dry, TD 1,547 ft.

Clare County, Grant Township: Ward J. Blunt 1 Walter, SW SW SW 24-17n-4w, Marshall 1,409 ft., dry, TD 1,415 ft.

Gladwin County, Grout Township: Ward Oil C. and W. B. Stewart 1 Gedney, NE SW NW 10-18n-2w, Dundee 3,826 ft., dry, TD 3,940 ft.

Ogemaw County, Mills Township: O. K. West, tr., 1 De Goyer, NE NW NE 7-21n-3e, dry in Richfield, TD 4,037 ft.

Southwest Texas

Atlantic Refining Completes Dagger Island Discovery

CORPUS CHRISTI.—Atlantic Refining Co. has completed its Dagger Island wildcat for an oil discovery in Nueces County. The 1 State Tract 341 flowed 31 bbl. of 41.4°-gravity oil on 7-hour test through perforations at 7,830-38 ft. Gravity of the oil was 41.4°. This is the second producer in Dagger Island field, being 3,900 ft. north of the discovery well, Shell Oil Co. 1 State Tract 342, which was completed as a gas-condensate well. It is also approximately 6 miles north of oil production from the same level on the west side of Mustang Island field.

Fred Scharf 1 August H. Ernst, wildcat test in Francisco Rolen League, Abstract 617, Bexar County, has been potentialed for 7 bbl. of oil daily. Production is from open hole at 1,233-48 ft. in broken sand. Gravity of the oil was 37°.

Milam Drilling Co. 1 J. C. Cox, Frio County wildcat, has tested oil from the Navarrro zone and set casing for completion attempt as a new oil-field discovery. The sand was topped at 4,616 ft. Operator ran a drill-stem test at 4,617-25 ft., using ¼-in. top and open-bottom choke, and recovered 600 ft. of oil. Total depth of the hole is 4,630 ft. and operator has set 5½-in. casing to 4,617 ft. for open-hole completion in the Navarro zone. The prospective discovery is located in Albert Fisher Survey 229, 4 miles northwest of Charlotte field in Atascosa County.

Although full details have not been released, Taylor Mayfair Properties of McAllen 1 Boris Marinoff, Hidalgo County wildcat, is reported to have recovered 1,600 ft. of oil on drill-stem test at 5,852-56 ft., and then cored further into the sand and made oil on a second test. The well is coring below 6,185 ft. The prospective discovery is located south of Alamo, in Lot 85 of Santa Ana Development Co. Unit 3, Porcion 72.

SOUTHWEST TEXAS (DISTRICTS 1 AND 4) SUCCESSFUL WILDCATS

Hidalgo County: Gas discovery—Hydrocarbon Production Co., Inc., 1 Schwarz-Ritcheson, Lot 4, Block 24, Capisallo Dist. Subd., 1 mi. from Lacy field, TD 7,545 ft., perf. Frio 7,230-43½ ft., IP: 5,800,000 cu. ft. of gas per day, open flow.

Nueces County: New pay at Nueces Bay—Erle P. Halliburton Co. 1 State Tract 723, Nueces Bay State Tract 723, TD 4,045 ft., perf. 3,764-68 ft., IP: 11,000,000 cu ft. of gas per day, open flow.

San Patricio County: New pay at Mud Flats—Sun Oil Co. 1 Milton Gabriel, Sec. 55 and 56, 6th Subd. of Taft Farm Lands, TD 10,015 ft., perf. 9,018-28 ft., IP: 11 bbl. oil per day, 34.5° gravity.

New pay at Portilla—Superior Oil Co. 26 Minnie S. Welder, Sec. 19, Welder Ranch Subd., TD 9,000 ft., perf. 7,448-56

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says W. C. Patton, owner of W. C. Patton Drilling Company, Stillwater, Oklahoma

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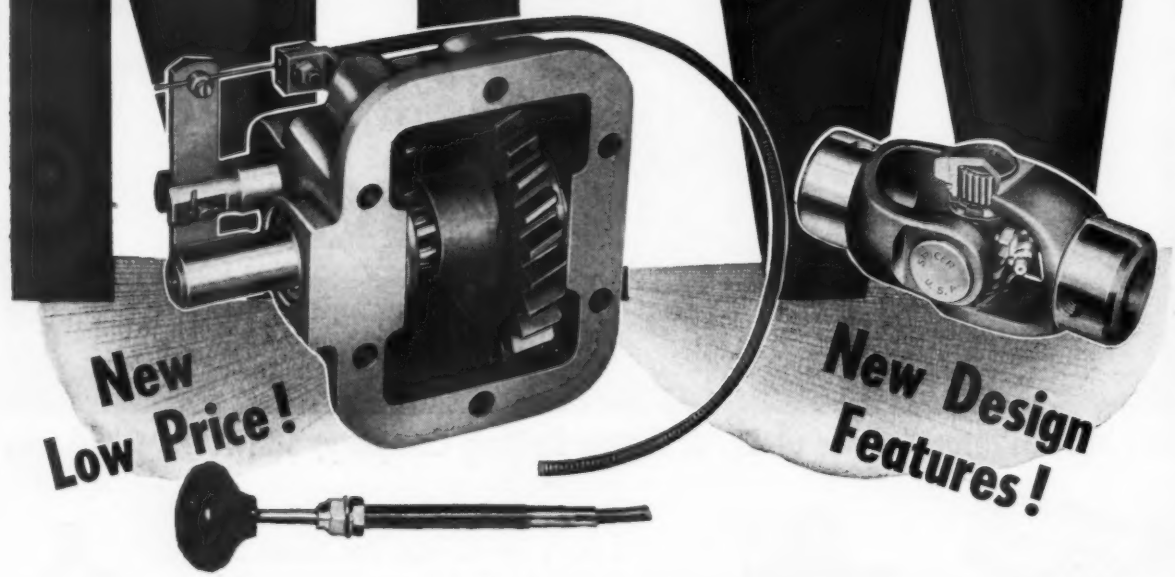

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SOUTHWEST TEXAS (DISTRICTS 1 AND 4) WILDCAT FAILURES

Bexar County: W. W. Kelley 1 George M. Aron, J. Canan Sur. 191, A-180, dry, TD 1,493 ft.

Duval County: Argo Oil Corp. 12 John Bennett, Jr., et al, J. Poitevent Sur. 433, A-443, dry, TD 3,198 ft.

Milam County: Owen Hembree 1 Crenan Ranch Estate, William J. Cowan Sur., dry, TD 408 ft.

Nueces County: Southern Minerals Corp. A-1 Groeneveld, Richard King Farm Lots, Sec. 45, dry, TD 6,400 ft.

Starr County: E. L. Cox-Daubert & Achning 1 Salvador Salinas, Block 31, Porc. 109, dry, TD 2,250 ft.

Webb County: Amerada Petroleum Corp. 1 Taylor & Nunley Cattle Co., BS&F Sur. 806, A-2,161, dry, TD 6,760 ft.

Williamson County: Amos Peters, L. C. Anderson, H. Burns & M. Sorenson 1 Walfred Johnson, John Pharass Sur., dry, TD 1,200 ft.

Earl C. Ward 1 Bowers, Pedro Zarza Sur., dry, TD 200 ft.

Canadian Fields

Southern Alberta Wildcat Strikes Gas, Blows Wild

CALGARY.—A well in southern Alberta, about 108 miles east southeast of Calgary, that discovered natural gas in the Bow Island sand about 2 weeks ago, went wild, and is blowing gas at an estimated rate of 20,000,000 cu. ft. daily. The wild well is Sweetgrass-Maygill 1A, in LSD 13, 34-21-12w4, about 8 miles north of Princess oil and gas field. Company officials reported that mud trucks are waiting at the town of Brooks, as they cannot get through to the well. McKinley Wild Well Service of Houston, Tex., is flying personnel to Calgary to supervise efforts to kill the well. The only casing in the hole is 450 ft. of 10¾-in. surface pipe. Around 1,050 ft. of drill pipe is still in the hole. So far the well has not caught fire.

Participants in the Sweetgrass-Maygill 1A venture, which is located in the Steveville area, include Sweetgrass Oil Co., Maygill Petroleums, Ltd., of Toronto, and Matlo Oils, Ltd., of Calgary. Discovery at the Steveville well was recorded in the Bow Island sand interval at 2,578-95 ft. where gas flowed during drill-stem test at the rate of 1,825,000 cu. ft. daily. An unnamed sand, above the Lower Cretaceous, from 2,912-16 ft., drill-stem tested gas at rate of 1,760,000 cu. ft. daily prior to the blowout. Total depth is currently 2,934 ft.

Success has been assured in the D2 zone of Devonian at a South Leduc venture being drilled by four Canadian independents on a quarter section farmout from Pacific Petroleums, Ltd. The Homestead-Tower-Long Island 1, in LSD 5, 7-49-26w4, is ¼ mile south of Mic-Mac 2, D2 oil well. A 76-minute drill-stem test from 5,468-87 ft. gave a maximum natural gas flow rate of 285,000 cu. ft. daily, with oil reaching the surface 61 minutes after valve was opened. The well will be carried down to test the D3 zone prior to completion.

Pacific Petroleums, Ltd., and its associated company, Peace River Natural Gas Co., made a natural gas discovery in northeastern British Columbia. The discovery well is Pacific-Sunrise 3, in LSD 10, 7-79-16w6, about 18 miles northwest of Dawson Creek. Discovery was made in the Commotion Creek sands, with gas flow rate on drill-stem test of 1,450,000 cu. ft. per day. An 80-minute test was made at 3,086-3,126 ft. The well is now coring ahead for test of deeper formations.

Anglo-Calmont-Golden Spike 1 well rated a 6,000,000-cu. ft. gas flow during a Lower Cretaceous drill-stem test run prior to reaching the base of that zone and hitting salt water. In addition to the Cretaceous strike, the well also found gas in the higher Viking section. The crew is now heading for the main Devonian objectives.

On the first test (at 4,420-27 ft.), in addition to the 6,000,000 cu. ft. of gas, there was a recovery of 10 ft. of naphtha. The last test, from 4,427-34 ft., had a gas flow of 600,000 cu. ft. daily plus a flow of salt water to the surface in 45 minutes.

CANADIAN SUCCESSFUL WILDCAT

Delhi-Amcan-Castor 2, LSD 11, 28-37-13w4, TD 3,600 ft., capped gas well.

CANADIAN WILDCAT FAILURES

Imperial-Redwater Piccadilly 1, LSD 4, 17-52-26w4, TD 6,525 ft.

Shell-Horse Hills 1, LSD 13, 24-84-2w5, TD 5,010 ft.

Western Keystone 31-1, LSD 1, 31-27-6w5, TD 10,152 ft.

Great Plains-Seaboard-Pelican Lake 2, LSD 5, 34-79-21w4, TD 2,410 ft.

Cal Standard-Samson 4-35, LSD 4, 35-44-23w4, TD 6,340 ft.

Shell-Trout Mountain 2, LSD 16, 36-88-4w5, TD 2,454 ft.

Socony-Utikuma 1, LSD 12, 10-78-8w5, TD 5,944 ft.

Great Plains-Seaboard-East Wabiskaw 1, LSD 4, 13-79-23w4, TD 1,508 ft.

Great Plains-Seaboard-North Wabiskaw 1, LSD 8, 13-80-23w4, TD 1,572 ft.

EASTERN CANADA

Ontario.—Drilling for oil and gas, primarily in Grey and Bruce counties, Ontario, will be undertaken by Hodopar Oil & Gas Co., recently organized at Wiarton, Ont. Drilling in Bruce County near Hepworth at one time indicated a small commercial-gas production, and oil indications have also been encountered south of Georgian Bay and to the north, on Manitoulin Island.

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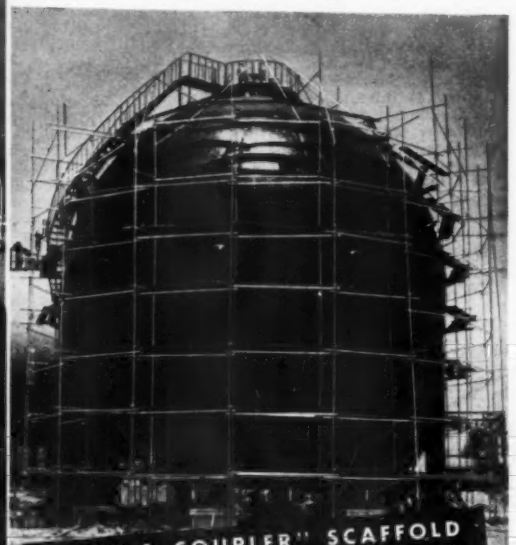

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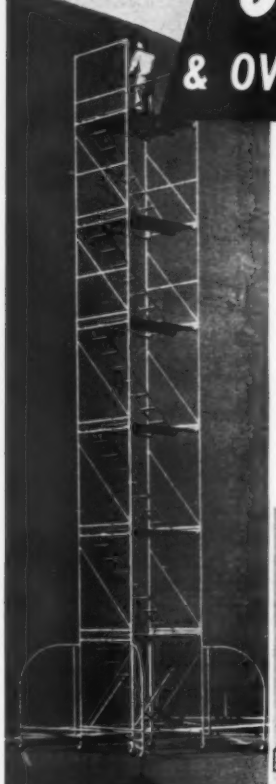

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Frogtown Silurian Well Flows 100 Bbl. Per Hour

SILURIAN production of the recently opened pool at Frogtown, 6 miles northwest of Carlyle, Clinton County, has been extended ½ mile southwest into the townsite with a well flowing initially at the rate of 100 bbl. per hour. The extension well, the third for the area (one a McClosky producer), is E. J. Goldschmidt and H. H. Robison 1 Jaske Community, located 100 ft. south and 330 ft. west of the NEc NE 1-2n-4w. With flow restricted through ¼-in. choke, it made 865 bbl. in 24 hours.

The Silurian pay zone, believed to be associated with a "reef," was topped at 2,264 ft. (surface elevation 457 ft.). Pay was penetrated to 2,280 ft. Casing was run to 2,251 ft.

In the meantime, the discovery well, Gulf Refining Co. 1 Frank Warnecke, NE NE NW 6-2n-3w, which was completed in the same zone, is being plugged back to the McClosky lime, in which its north offset, W. C. McBride 1 Lillie Schroeder, SE SE SW Fractional Section 31-3n-3w, was completed a week ago. The Gulf discovery producer has been flowing 15 bbl. of oil and making 1,500,000 cu. ft. of gas per day, but promises to be a much better well in the shallower horizon. McClosky saturation in this well was logged at 1,194-1,211 ft. A drill-stem test at the time had a good flow of clean oil with a substantial showing of gas.

A new producing area is indicated in the Buford area, in southeastern Daviess County, near the Ohio County line, where Simon Lebow is testing his 1 Mosley, C NE NE 2-M-30. Pay zone is the Tar Springs sand at 946-93 ft. The well filled 500 ft. with oil when plug was drilled out. Pay was shot with 30 quarts. The location is about 3 miles northwest of the town of Buford and about a mile from other production in the area.

Slagter Producing Co. has a prospective Jackson sand discovery just north of the Haubstadt townsite, 14 miles north of Evansville, in southern Gibson County, Indiana. Its 1 Victor Pohl, SE NE NW 31-3s-10w, got 100 ft. of oil-cut mud in a 90-minute drill-stem test of that sand, in which saturation was logged at 1,852-73 ft., on which casing has been cemented at 1,845 ft. Hole was drilled to 2,317 ft.

ILLINOIS SUCCESSFUL WILDCAT

Clinton County: W. C. McBride 1 Schroeder, SE SE SW 31-3n-3w, IP 177 bbl., McClosky 1,207-17 ft., TD 1,217 ft. (new pay Frogtown pool).

ILLINOIS WILDCAT FAILURES

Christian County: Collins Brothers 1 Simpson, SW SE SW 23-14n-1e, dry, TD 2,411 ft.

Macon County: F. L. Runyon et al., 1 Wilkinson, SW SW NE 25-16n-3e, dry, TD 2,528 ft.

INDIANA WILDCAT FAILURE

Knox County: George & Wrather 1 Hill, NE NE NW Projected Section 4-5n-9w, (Militia Donation 198), dry, TD 1,655 ft.

WESTERN KENTUCKY WILDCAT FAILURE

Muhlenberg County: Ellison & Malone 1 Carver, NE NE SW 3-G-30, dry, TD 1,251 ft.

EASTERN KENTUCKY

ASHLAND.—In Greenup County, 3-Y-79, Dixie King Oil & Gas Co. 1 Wain Boggs topped Corniferous lime at 1,133 ft. and was drilling ahead at 1,143 ft. with a small show of oil. This is currently the only wildcat drilling in the county and is located 6 miles west of Greenup, the county seat.

In the Pike County sector of Big Sandy

(Continued on page 403)

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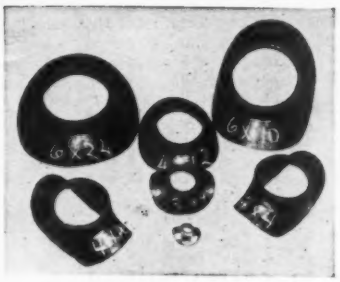

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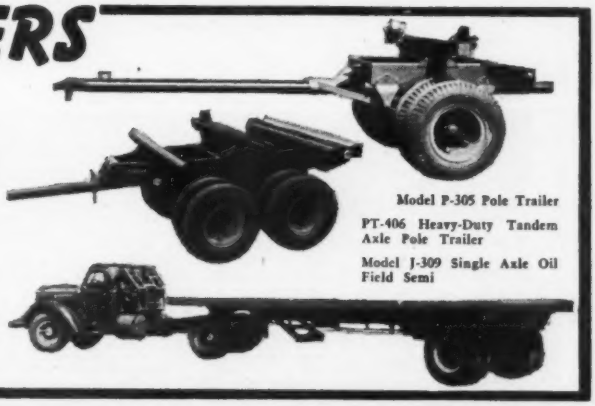

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IN CANADA — UPTON-BRADEEN-JAMES, LTD. — 990 BAY STREET, TORONTO, 3464 PARK AVE., MONTREAL

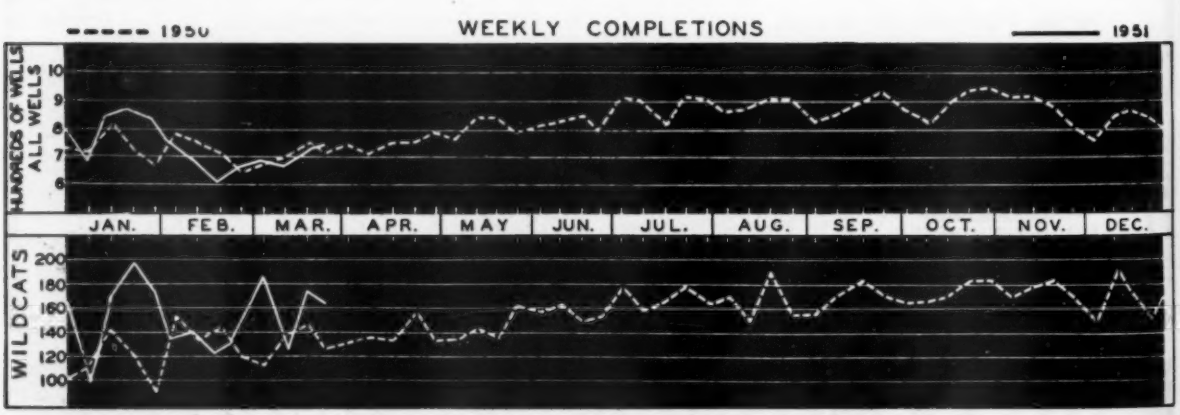
CURRENT STATISTICS

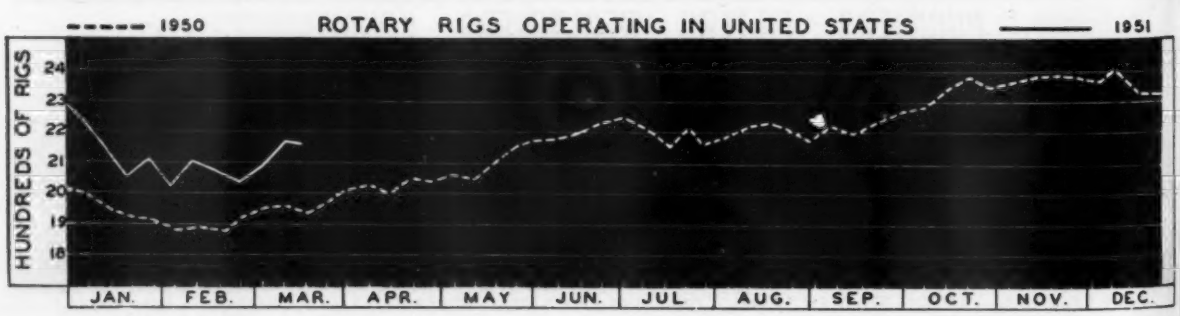
EXPLORATION

WEEKLY WELL COMPLETIONS . . . . . WEEK ENDED MARCH 24, 1951

	Total of all wells					Mar. 24		Wildcat completions and discoveries					Cumulative total, 1951				
	Comp.	Oil	Gas	Dry	Footage	1951	1950	Oil	Dist.	Gas	Dry	Total	Oil	Dist.	Gas	Dry	Total
New York	9	5	0	*4	13,104	90	137	0	0	0	0	0	0	0	0	0	0
Pennsylvania	15	5	3	†7	30,016	175	245	0	0	0	0	0	0	0	0	1	1
West Virginia	8	0	7	1	22,435	137	145	0	0	0	0	0	0	0	3	2	5
Ohio	13	4	4	‡5	29,375	163	200	0	0	0	0	0	1	0	2	5	8
Indiana	5	2	0	3	6,931	208	242	0	0	0	1	1	4	0	1	48	53
Kentucky	16	6	4	6	33,409	177	190	0	0	0	2	2	2	0	0	26	28
Illinois	22	10	0	12	52,960	381	477	1	0	0	2	3	11	0	0	54	65
Michigan	14	4	1	9	38,694	148	171	0	0	1	6	7	3	0	3	58	64
Kansas	75	35	16	§24	243,423	904	754	4	0	0	11	15	39	0	2	160	201
Nebraska	7	3	0	4	25,862	70	17	0	0	0	1	1	2	0	1	30	33
Oklahoma	102	58	6	§38	384,182	1,216	1,105	2	1	1	14	18	46	1	7	154	208
Texas	313	200	13	100	1,504,935	3,615	3,532	17	2	4	54	77	144	16	23	640	823
North Central (Dist. 7-B & 9)	87	49	0	38	290,864	1,053	1,074	8	0	0	21	29	67	0	1	251	319
West (Dist. 7-C & 8)	91	69	0	22	524,963	1,106	1,032	2	2	0	13	17	31	4	0	136	171
Panhandle (Dist. 10)	10	5	4	1	30,881	164	255	0	0	0	0	0	0	0	0	5	5
Eastern (Dist. 5, 6, & 6-P)	21	15	0	6	98,414	244	248	0	0	0	4	4	0	0	0	48	48
Gulf Coast (Dist. 2 & 3)	56	36	7	13	344,035	529	479	5	0	2	8	15	27	8	17	94	146
Southwest (Dist. 1 & 4)	48	26	2	20	215,778	519	444	2	0	2	8	12	19	4	5	106	134
Louisiana	43	23	3	17	293,113	471	546	1	0	0	7	8	14	0	3	65	82
Northern	23	12	3	8	101,369	221	277	0	0	0	3	3	3	0	2	32	37
Southern	20	11	0	§9	191,744	250	269	1	0	0	4	5	11	0	1	33	45
Arkansas	13	6	2	5	42,111	89	78	0	0	1	3	4	1	0	1	14	16
Mississippi	4	0	0	4	31,442	53	68	0	0	0	3	3	3	1	0	22	26
Southeastern States	0	0	0	0	0	13	13	0	0	0	0	0	0	0	0	2	2
Montana	5	1	0	4	10,748	38	30	0	0	0	4	4	0	0	0	7	7
Wyoming	19	11	0	8	97,939	153	128	0	0	0	3	3	3	0	0	23	26
Colorado-Utah	5	1	1	3	20,070	58	17	0	0	1	2	3	2	0	1	30	33
New Mexico	11	8	0	3	47,801	162	159	0	0	0	1	1	3	0	5	16	24
California	46	33	0	¶13	177,215	444	389	1	0	0	10	11	9	0	1	92	102
Miscellaneous (Md.)	2	0	2	0	8,051	10	3	0	0	2	0	2	0	0	5	5	10
Total United States	747	415	62	270	3,113,866	8,775	8,646	26	3	10	124	163	287	18	58	1,454	1,817
Total previous week	731	401	55	275	2,994,739	....	....	30	1	7	136	174	261	15	48	1,330	1,654
Total March 24, 1950	721	394	53	274	2,654,350	....	....	15	2	3	106	126	213	18	52	1,263	1,546

Service wells included: *4, †6, ‡2, §1, ¶3.





DAILY AVERAGE PRODUCTION FOR WEEK

	Mar. 24 crude oil	B. of M. Mar. demand	Mar. 17 crude oil
Alabama	2,800	2,400	3,250
Arkansas	78,950	88,000	78,900
California	966,800	970,000	966,300
Colorado	81,400	78,000	78,600
Eastern	61,225	66,000	63,700
Florida	1,550	1,600	1,625
Illinois	163,500	166,000	163,900
Indiana	27,200	31,000	26,600
Kansas	314,600	306,000	316,800
Kentucky	26,900	31,000	28,600
Louisiana	610,000	632,009	609,750
North Louisiana	114,000	.....	113,750
South Louisiana	496,000	.....	496,000
Michigan	38,900	45,000	39,100
Mississippi	98,500	114,000	100,400
Montana	23,700	23,000	24,000
Nebraska	10,400	8,000	10,200
New Mexico	141,000	140,000	141,000
Oklahoma	501,400	495,000	498,800
Texas	2,616,550	2,460,000	2,616,550
Dist. 1 (Southwest)	32,975	.....	32,975
Dist. 4 (Southwest)	244,150	.....	244,150
Dist. 2 (Gulf Coast)	157,100	.....	157,100
Dist. 3 (Gulf Coast)	463,900	.....	463,900
Dist. 5 (Eastern)	48,650	.....	48,650
Dist. 6 (Eastern)	105,725	.....	105,725
East Texas field	271,000	.....	271,000
Dist. 7-C (West)	84,950	.....	84,950
Dist. 8 (West)	892,500	.....	892,500
Dist. 7-B (W. Central)	79,200	.....	79,200
Dist. 9 (N. Central)	147,400	.....	147,400
Dist. 10 (Panhandle)	89,000	.....	89,000
Utah	3,700	5,000	3,800
Wyoming	193,900	183,000	193,300
Total United States	*5,962,975	5,845,000	5,965,175
Change from prev. week, down	2,200		
Canada	77,310	.....	94,785

Total U. S. production January 1-March 24 .... †502,564,615 bbl.
Same period last year (crude plus cond.) ..... 409,848,000 bbl.

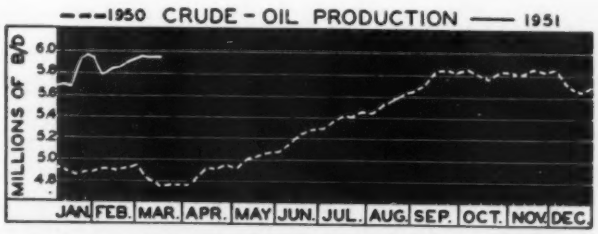
*Not including 109,025 bbl. condensate. †Including 8,784,335 bbl. condensate.

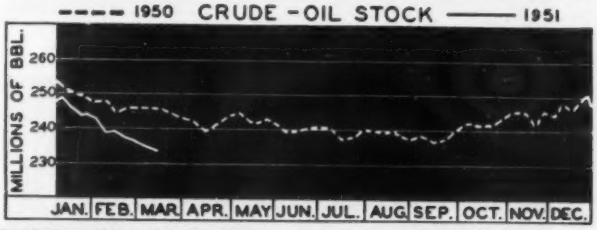
CRUDE-OIL STOCKS BY STATES OF ORIGIN*

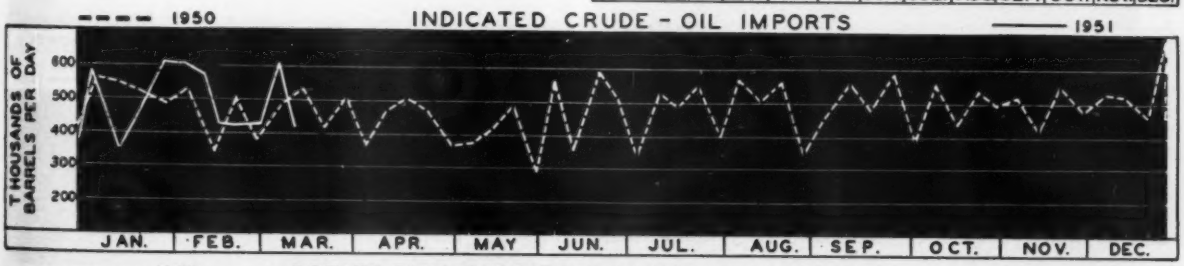
(Thousands of barrels)

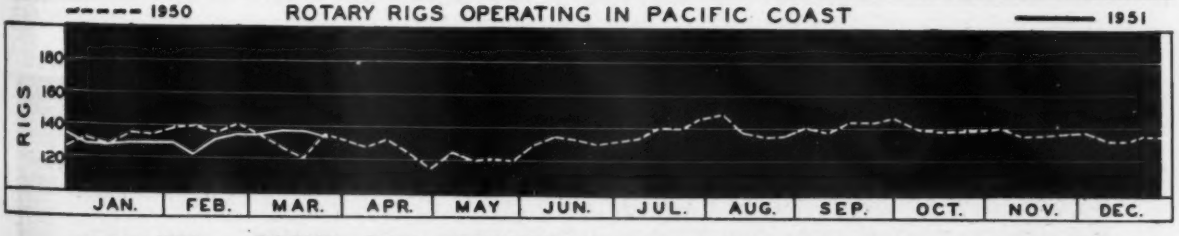
	Mar. 17, 1951	Mar. 10, 1951	Mar. 18, 1950
Pennsylvania Grade	2,034	2,104	2,817
Other Appalachian	1,081	1,268	1,726
Illinois, Indiana, Michigan	9,038	8,811	10,566
Arkansas	2,726	2,325	3,145
Louisiana	14,055	14,340	16,244
North	3,084	2,934	3,744
Gulf	10,971	11,406	12,500
Mississippi	2,844	2,896	2,711
New Mexico	7,155	6,879	6,920
Oklahoma and Kansas	37,096	37,353	35,285
Texas	108,820	109,743	106,582
East Texas	13,960	13,900	14,356
West Texas	43,393	43,703	37,736
Texas Gulf	24,438	24,750	28,460
Other Texas	27,029	27,390	26,030
Rocky Mountain	12,445	12,280	13,419
California	29,820	30,220	38,185
Foreign	6,001	6,320	6,976
Total	233,115	234,539	244,576

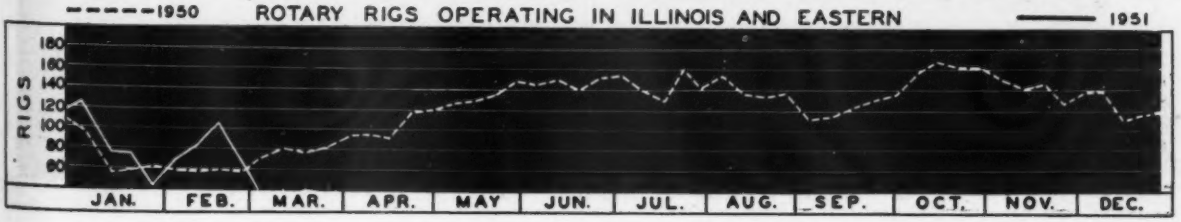
*Bureau of Mines.









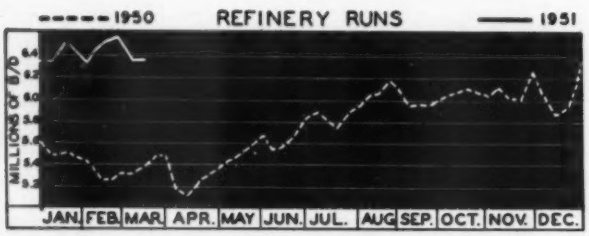


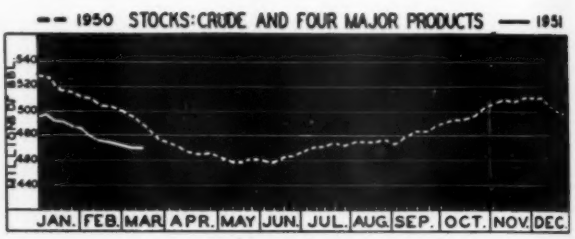
A.P.I. REFINERY REPORT, MARCH 17

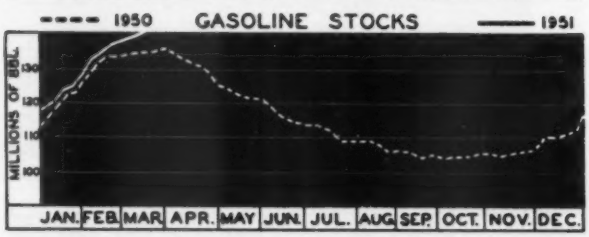
(Thousands of barrels)

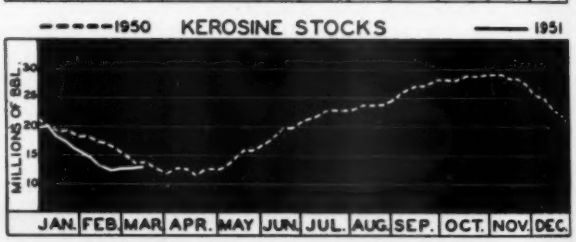
District—	Daily avg. crude runs	Daily average production				Stocks at refineries, bulk terminals, in transit and in pipe lines				Bureau of Mines, March 1950				
		Gasoline*	Kerosine	Distillate	Residual	Gasoline†	Kerosine	Distillate	Residual	Daily avg. crude runs	Daily average production: Gasoline*	Kerosine	Distillate	Residual
East Coast	949	389.4	49.6	227.4	216.1	27,243	5,571	13,157	8,176	810	330.6	30.2	182.6	204.3
Appalachian:														
District 1	107	42.0	7.0	13.0	13.9	2,903	196	446	253	91	40.1	7.6	13.3	10.4
District 2	81	34.0	6.1	6.1	17.0	1,310	82	141	115	69	29.9	4.5	11.3	18.3
Ind., Ill., Ky.	1,216	602.7	74.6	225.3	184.6	31,569	2,712	7,240	3,073	1,032	526.8	67.4	169.2	191.9
Okla., Kans., Mo.	525	277.0	20.9	120.7	76.4	16,016	557	5,476	1,055	426	235.8	18.2	89.4	54.4
Inland Texas	213	138.7	10.1	34.7	39.6	4,175	320	605	755	199	141.2	11.0	26.7	44.1
Texas Gulf Coast	1,555	680.9	116.1	370.6	305.7	23,244	1,476	5,772	4,401	1,234	579.0	102.6	209.4	216.9
La. Gulf Coast	504	211.0	71.9	98.4	69.0	8,754	1,228	2,134	1,888	431	209.3	56.6	92.7	50.3
N. La. and Ark.	65	22.1	6.3	13.6	4.7	2,715	175	824	54	64	25.8	6.8	12.8	13.6
Rocky Mountain:														
New Mexico	11	5.6	.....	2.0	2.3	95	25	59	29	12	6.3	.4	1.9	2.9
Other Rocky Mtn.	208	99.2	7.7	37.3	41.6	5,514	222	1,300	636	170	79.5	6.1	32.0	33.7
California	938	403.3	5.1	106.9	382.4	17,133	520	7,812	17,318	798	334.5	14.4	96.4	311.0
March 17, 1951	6,372	2,905.9	375.4	1,256.0	1,353.3	140,671	13,084	44,966	37,753	5,336	2,538.8	325.8	937.7	1,153.8
March 10, 1951	6,366	2,909.7	390.0	1,321.3	1,357.0	139,056	12,802	46,022	38,224	.....	.....	.....	.....	.....
March 18, 1950	5,381	2,562.3	304.1	951.9	1,144.9	135,052	13,592	43,102	41,966	.....	.....	.....	.....	.....

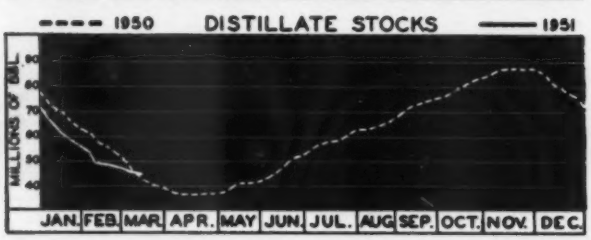
*At refineries including natural blended. †Finished and unfinished.

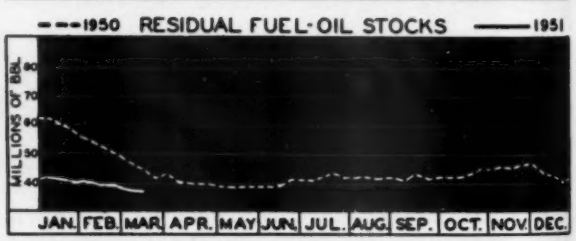


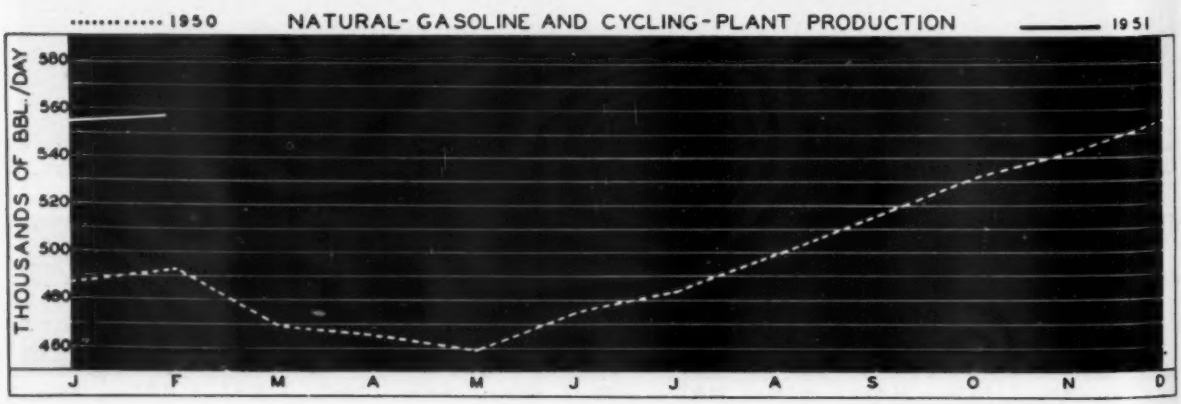












CRUDE PRICES
GRAVITY SCHEDULE

	Signal Hill, Calif.‡	Oklahoma, Kansas	Gulf Coast Tex.*	West Tex.†
18-18.9	$1.93	....	....	....
19-19.9	1.98	....	....	....
20-20.9	2.03	$2.25	....	$2.12
21-21.9	2.07	2.27	....	2.14
22-22.9	2.12	2.29	....	2.16
23-23.9	2.18	2.31	....	2.18
24-24.9	2.24	2.33	$2.56	2.20
25-25.9	2.30	2.35	2.58	2.22
26-26.9	2.36	2.37	2.60	2.24
27-27.9	2.41	2.39	2.62	2.26
28-28.9	2.46	2.41	2.64	2.28
29-29.9	2.52	2.43	2.66	2.30
30-30.9	2.57	2.45	2.68	2.32
31-31.9	2.62	2.47	2.70	2.34
32-32.9	2.68	2.49	2.72	2.36
33-33.9	....	2.51	2.74	2.38
34-34.9	....	2.53	2.76	2.40
35-35.9	....	2.55	2.78	2.42
36-36.9	....	2.57	2.80	2.44
37-37.9	....	2.59	2.82	2.46
38-38.9	....	2.61	2.84	2.48
39-39.9	....	2.63	2.86	2.50
40 and above	....	2.65	2.88	2.52

*For crude from Daboval, El Campo, and Sand Point.

†Includes Lea County, New Mexico. Last general price change represented a 50-cent increase becoming effective December 6 1947.

‡Standard Oil Co. of California.

FLAT CRUDE PRICES

Representative posted schedules per barrel.	
East Texas†	$2.65
Kettleman Hills, California*	2.90
Beauregard Parish	2.60
Illinois Basin	2.77
Pecos County, Texas (Yates)	2.35
Bradford, Pennsylvania	4.25
Eastern Ill. and Western Ind.†	2.77
Tomball, Texas Gulf Coast	2.83

*37°-37.9°. †35° and above.

RECENT announcement of reductions in spot tanker rates for coastwise trade seems to be the result of a normal seasonal trend and not an indication of general rate reductions. A clean vessel was reported fixed at Maritime Commission base plus 170 per cent compared with the ceiling of 200 per cent over the base. This reduction of 30 points represents a decrease of about .25 cent for gasoline, and the same rate for dirty vessels would mean a cut of about 14 cents a barrel in the cost of moving heavy fuel. However, Gulf Coast prices and New York Harbor prices are still out of balance by more than 50 cents a barrel, based on these latest spot tanker rates.

Continued easing in markets for home-heating oils is noted for most areas. Lingering cold weather with snow in some north-central states is supporting inland demand, but some suppliers in the Mid-Continent report that the demand is not fully reflected in shipments out of the area, indicating that secondary suppliers are reducing inventories of distillates in preparation for expected high demands for gasoline during the summer months.

Reductions continue in distillate inventories, but the downward trend is not expected to last as long as it did last year. Total distillate stocks were cut by 1,056,000 bbl. for week ended March 17, but 613,000 bbl. of the total was in California.

Primary stocks of the four major products in all areas are only 2,762,000 bbl. greater than at this time last year. However, the distribution of stock increases must be considered since it is part of the supply program for a given area. Major product stocks, located east of California, are 15,100,000 bbl. greater than at the middle of March 1950. Gasoline accounts for 9,000,000 bbl. of the total. East-of-California distillate is up 3,800,000 bbl.

REPRESENTATIVE QUOTATIONS

Representative spot-market quotations of leading suppliers as of March 26, 1951. Figures are f.o.b. plant for tank-car shipments in cents per gallon, except for residual fuel oil which shows the price per barrel and wax, in cents per pound

GASOLINE, KEROSINE, AND FUEL OILS

	Mid-Continent Group 3	New York Harbor (barge)	Texas Gulf Coast
Regular gasoline, 80-82 octane	10⅛-10½	12-12.75	10¾-11
Premium gasoline, 86-88 octane	11⅛-11½	13.5-13.75	11½-12
42-44 w.w. kerosine	9¼-9⅜	10-10.1	8¾-9
No. 2 straw fuel oil	8¼-8⅝	9-9.25	7¾-8
No 6 residual	$1.80-1.90	$2.25-2.30	$1.75-1.90

NATURAL GASOLINE

	Group 3	North Texas	N. La.
Grade 26-70	6⅜	5⅞	6⅛
Grade 18-55	7.65	7.15	7.40

LUBRICATING OILS

South Texas

200 vis., No. 2-3 neutral	13-13.5
750 vis., No. 3-4 neutral	16
2,000 No. 5-6 neutral	18-19

Mid-Continent

150-160 vis., D bright stock, 0-10 pp.	29-30
200 vis., No. 3 neutral, 0-10 pp.	17.5-18.5

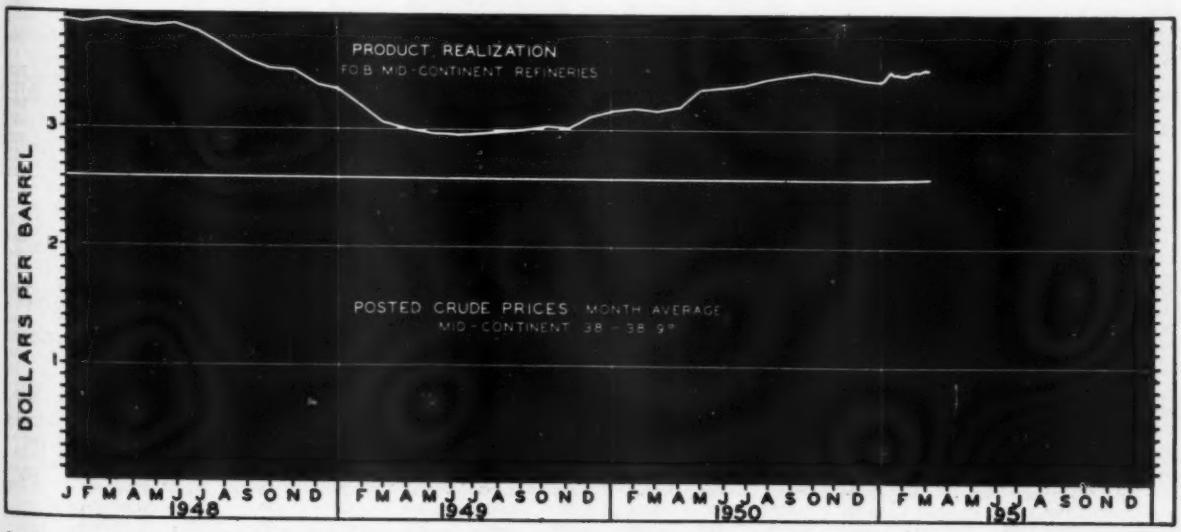
Western Pennsylvania

145-155 vis., 10 p.t. bright stock	32.5
180 vis., 0 p.t. neutral	31.5

WAX

Mid-Continent

132-134 A.M.P.	6.0


PRODUCT REALIZATION
F.O.B. MID-CONTINENT REFINERIES
POSTED CRUDE PRICES MONTH AVERAGE
MID-CONTINENT 38 - 38.9°
DOLLARS PER BARREL
3
2
1
J F M A M J J A S O N D
1948
F M A M J J A S O N D
1949
F M A M J J A S O N D
1950
F M A M J J A S O N D
1951

In this trend chart refinery realization is based on average Mid-Continent grade crude oil (not 38° gravity only) and average prices for refinery products as published in The Oil and Gas Journal basis Oklahoma (Group 3). Refinery yields confined to gasoline, kerosine, distillate, and fuel oil. Realization averaged $3.52 for week ended March 17, $3.54 for previous week, and $3.22 for March 1950.

Completions for First 2 Months Edge Upward, Both in Number and Footage

by Polly DeArmond

THE total number of wells completed during the first 2 months of this year edged past the corresponding period last year by 126 wells, or 2.1 per cent, and footage increased more than 1½ million feet, or 6.7 per cent. This emphasis on deep drilling is further reflected by the comparison of average depths for the two periods: average footage per well in January-February 1951 figures was 3,933 ft., and only 3,765 ft. in 1950.

Individual Increases

The cumulative analysis shows four areas out of seven had gains in both completions and footage drilled. The Rocky Mountain region increased 26 wells, or 20.3 per cent, and some 94,000 ft., or 15.9 per cent. The Mid-Continent division was up 259 completions, or 19.4 per cent, and jumped over a million feet, or 22.7 per cent. Shallower wells were finished in California during 1950; that state reported a gain of 40 completions, or 14.9 per cent, with only a rounded increase of 1,000 ft. in a total of 1¼ million feet drilled. Texas-New Mexico noted gains of 76 wells, or 3.1 per cent, and 682,000 ft., or 6.5 per cent, over January-February 1950.

Decreases by Areas

Continuing a long downward trend, the Appalachian fields recorded the largest loss in completions, off 96 wells (or 22.6 per cent), and down about 57,000 ft., or 7.4 per cent. The southern states dropped 74 wells, or 14.6 per cent, and decreased 221,000 ft., or 7.7 per cent, from the first 2 months of 1950. The North Central section declined 105 completions, or 11.8 per cent, and 48,000 ft., or 2.8 per cent, in total footage drilled.

February vs. February

While there were 2,729 wells completed with total footage of 10,824,010 ft. in February 1951, operations fell below the corresponding month of last year. The number of completions declined 167 wells, or 5.8 per cent, and footage was off 122,000 ft., 1.1 per cent.

The Eastern area reported a combined total of 156 wells, down 23.9 per cent, and some 369,000 ft., a decrease of 2.2 per cent. The Southern states decreased 47 wells, or 20.5 per cent, and dropped 61,000 ft., or 4.7 per cent. Declines of 55 wells (14.1 per cent) and 18,000 ft. (2.3 per cent) were reported in the North Central section, and Texas-New Mexico slipped 118 wells (9.3 per cent) and 436,000 ft. (7.9 per cent) in footage drilled.

The Rocky Mountain region showed large gains in both wells and footage: completions increased 27 wells, or 65.8 per cent, and footage was up 114,000 ft., or 52.5 per cent. The West Coast states completed 29 more wells, or 22.3 per cent, for 47,000 additional feet., or 8.3 per cent, compared with operations in February 1950. The Oklahoma-Kansas-Nebraska-Missouri division reported increases of 7.2 per cent in completions (up 46 wells) and 10.8 per cent in footage (up 240,000 ft.).

SUMMARY OF COMPLETIONS . . . . FEBRUARY 1951

	Total comp.	Oil	Gas	Dry	Under 2,500 ft.	2,500-5,000 ft.	5,000-7,500 ft.	7,500-10,000 ft.	10,000-12,500 ft.	Over 12,500 ft.	Total footage	Rigs and drilling
New York	30	16	0	14	30	0	0	0	0	0	43,577	39
Pennsylvania	74	35	9	30	68	6	0	0	0	0	158,242	216
West Virginia	51	6	32	13	22	27	2	0	0	0	154,957	197
Maryland	1	0	1	0	0	1	0	0	0	0	3,522	14
Ohio	49	18	12	19	21	28	0	0	0	0	116,444	109
Kentucky	43	21	5	17	34	9	0	0	0	0	73,467	77
Illinois	132	71	0	61	39	93	0	0	0	0	346,486	202
Indiana	66	21	1	44	57	9	0	0	0	0	108,176	183
Michigan	45	16	1	28	24	21	0	0	0	0	113,548	114
Kansas	299	136	30	133	26	272	0	1	0	0	997,205	386
Neb., Mo., Iowa	§25	9	3	13	5	17	3	0	0	0	84,734	41
Oklahoma	359	209	23	127	95	181	61	11	11	0	1,372,436	763
Texas	1,094	682	62	350	311	366	298	93	20	6	4,827,288	1,445
North	200	106	0	94	111	61	27	1	0	0	570,580	167
West Central	134	69	1	64	60	60	14	0	0	0	403,418	165
West	348	268	0	80	61	87	146	36	12	6	1,902,758	552
Panhandle	66	30	34	2	8	57	1	0	0	0	197,945	101
East	66	41	4	21	19	28	12	7	0	0	267,767	81
Gulf Coast	144	82	19	43	7	46	52	32	7	0	865,987	202
Southwest	136	86	4	46	45	27	46	17	1	0	618,833	177
Louisiana	138	74	9	55	21	23	27	26	35	6	1,009,448	239
Northern	60	29	7	24	21	19	14	5	1	0	265,977	105
Southern	78	45	2	31	0	4	13	21	34	6	743,471	134
Arkansas	23	14	0	9	7	14	2	0	0	0	72,488	31
Mississippi	17	6	0	11	0	1	12	3	0	1	120,929	26
Ala., Ga., Fla.	4	3	0	1	0	3	0	1	0	0	18,530	5
Montana	10	8	0	2	6	4	0	0	0	0	25,500	¶39
Wyoming	43	27	2	14	5	12	20	4	1	1	229,686	**162
Colorado	11	4	0	7	1	2	7	0	1	0	58,777	51
Utah	2	0	0	2	2	0	0	0	0	0	1,750	18
New Mexico	52	27	15	10	12	19	11	5	4	1	256,196	††113
Nevada	2	0	0	2	0	1	0	0	1	0	14,436	3
California	159	115	4	40	52	71	22	6	8	0	616,188	238
Total February 1951	2,729	†1,518	209	*1,002	838	1,180	465	150	81	15	10,824,010	‡4,731
Total January 1951	3,372	1,917	221	1,234	1,049	1,458	574	208	74	9	13,172,011	4,636
Total February 1950	2,896	1,664	187	1,045	1,026	1,162	493	132	71	12	10,946,287	4,192
Cumulative 1951	6,101	3,435	430	2,236	1,887	2,638	1,039	358	155	24	23,996,011	.....
Cumulative 1950	5,975	3,472	414	2,089	2,138	2,394	955	316	150	22	22,492,668	.....

*Incl. 61 service wells: N. Y. 14, Pa. 29, Ohio 5, Ill. 2, Kans. 3, Okla. 6, S.W. Tex. 1, No. La. 1. †Incl. 26 distillate wells: Okla. 8, Tex. Gulf 6, S.W. Tex. 5, No. La. 1, So. La. 4, Miss. 2. ‡Incl. all wells rigged up and/or drilling at month end. §Incl. Iowa 1 dry at 2,505 ft. ¶Incl. 2 Idaho rigs. **Incl. 6 Dak. rigs. ††Incl. 4 Ariz. rigs.

EQUIPMENT MEN . . . in the News

Walker Reports on National Supply Financial Outlook

In the company's annual report, A. E. Walker, president of the National Supply Co., Pittsburgh, reviewed the past year's operations and presented the outlook for this year.

Concerning the company's financial position, which revealed sales in 1950 were $156,262,538 as compared with $130,885,882 in the previous year, Walker pointed out possible effects of the inflationary trend as he said, "In making comparisons with past years it is necessary to keep in mind that the present dollars represent much less money than they used to in terms of goods and services, and what now appears to be a comfortable working capital position may prove inadequate if inflation continues."

National Supply's modernization program which has entailed the expenditure of more than $25,000,000 is expected to be completed during the summer when improvements at the Ambridge plant are finished.

Losers Win After All In Halliburton Contest

In the recent contest held by Halliburton Portland Cement Co. to name its advertising trade character, all 650 entrants received Sheaffer Fineline automatic pencils.

Cash awards totaling $1,000 were awarded to three winners who selected the name "Hardy Hal," but Halliburton officials felt that names such as Shellburt, Hal C. Ment, Shelly, etc., should be rewarded.

The pencils carry on the theme of the contest, having a picture of Hardy Hal and the inscription "Meet Hardy Hal" written just below.

Worth Steel Co. is Acquired by C. F. & I.

On March 5, 1951, The Colorado Fuel & Iron Corp. formally completed acquisition of Worth Steel Co. at Claymont, Del. This plant will now be operated by a wholly owned subsidiary of C. F. & I. to be known as the Claymont Steel Corp.

Officers of the new corporation are: Charles Allen, Jr., chairman of the board; C. W. Meyers, president; A. F. Franz, executive vice president; Franklin Berwin, vice president and secretary; A. C. Bekaert, vice president of finance; F. S. Jones, vice president of sales; J. J. Martin, vice president of operations; H. C. Crout, treasurer; Earl D. Page, controller and assistant secretary. Manager of plant operations will be W. P. Worth; general manager of sales, R. M. Worth; and assistant treasurer and assistant secretary, E. H. Worth, Jr.

Fennie Made Department Manager at Ryerson Steel

John R. Fennie has been named manager of the tubular-products department of Joseph T. Ryerson & Son, Inc., steel distributors, Los Angeles, according to T. L. Kishbaugh, plant manager.

Fennie became a member of the sales staff of the Ryerson Los Angeles plant in 1946, after 2 years as assistant superintendent of open hearth of Kaiser Steel Co. In his new position with Ryerson Fennie heads the department responsible for merchandising tubular products including seamless and welded mechanical tubing, pressure tubing, hydraulic cylinder and line tubing, and structural tubing.

Hall, King Moved Up By Halliburton

J. W. HALL

FRANK KING

J. W. (Bill) Hall has been transferred from the West Texas division of Halliburton Oil Well Cementing Co. where he has been serving as district superintendent for several years. Hall began his employment with Halliburton at Abilene, Tex., in 1937 and he has been promoted to assistant division manager of the Rocky Mountain division wth headquarters in Casper, Wyo.

Frank King has been promoted from a cementer at Lance Creek, Wyo., to field man in charge of Halliburton operations at Newcastle and Lance Creek. King began his employment with Halliburton in 1926. He has worked in practically all the larger oil fields in the Mid-Continent and Rocky Mountain areas.

Oilwell Appoints Goff to Manage Centralia Store

James E. Goff, who joined Oil Well Supply Co. in 1938 as a clerk in the Centralia, Ill., store, has returned to that store as manager, C. H. Maynard, manager of this U. S. Steel subsidiary's eastern division, announced recently.

Goff's service with Oilwell has been in the Illinois district. Since August 1947 he has served as a storeman in the Salem, Ill., store, and prior to that he was located at Olney, Ill., and Chicago.

American Hoist Elects Carroll Vice President

John E. Carroll, general sales manager of American Hoist & Derrick Co., was elected by the board of directors to the office of vice president of sales.

Carroll, a graduate engineer from University of Minnesota, joined American Hoist in 1937 as a district representative. He resigned his sales position in 1945 to become a partner in the firm of Harron, Rickard & McCune Co., of Southern California, managing the construction machinery division. Carroll joined American Hoist as general sales manager in 1949.

Baird, Selander Advanced By Youngstown Sheet

Paul B. Baird, of Youngstown, has been named manager of standard pipe sales for The Youngstown Sheet and Tube Co. with offices in Youngstown. He succeeds Glenn W. Christopher, recently deceased.

Carl T. Selander, of Chicago, western representative for standard pipe products for the past year, has been promoted to assistant manager of standard pipe sales with headquarters in Chicago.

Baird joined Youngstown in 1925 as a clerk in rod and wire shipping. In 1926 and 1927 he was a tally clerk in tube-mill shipping. In 1928 he was transferred to the order department as a clerk and in 1937 was transferred to the pipe sales department. He was appointed assistant manager of standard pipe sales April 1, 1950.

Selander joined the company as a conduit salesman in Chicago in 1935. He was transferred to pipe sales in

the Chicago office in 1944 and was appointed western representative for standard pipe sales at Chicago office in March 1950.

Cooper-Bessemer Adds Woodard to Sales Staff

The Cooper-Bessemer Corp., prominent Ohio builder of diesel engines, gas engines, and compressors, has announced the appointment of Grant C. Woodard to its field sales and engineering staff. Woodard will directly assist C. J. Michelson who at present represents Cooper-Bessemer in the territories of Michigan, Ohio, West Virginia, Kentucky, and Tennessee, under the direction of F. M. Devin, territorial manager and manager of Cooper-Bessemer's Locomotive Diesel Engine Division.

Woodard has been undergoing extensive sales engineering training for several years at Cooper-Bessemer's Mount Vernon, Ohio, plant. He is a 1948 graduate of Cornell University and holds a bachelor of science degree in administrative engineering.

Brannon Transferred To Hobbs by Rector

J. G. Brannon, a representative of Rector Well Equipment Co., Inc., at Snyder, Tex., since May 1950, has recently been transferred to Hobbs, N. M.

Brannon graduated from Louisiana Polytechnic Institute where he received a B.S. degree in mechanical and electrical engineering. Following 4 years with the mechanical department of Texas & Pacific Railway, he was transferred to the mechanical engineer's office, doing locomotive test and design work. In 1945 he became a sales and service engineer for Hennessy Locomotive Lubricator Co. The year prior to joining Rector Brannon was a territory supervisor with the marketing division of Cities Service Oil Co.

Shaw Joins J. R. Meek As Sales Engineer

Joe C. Shaw, sales engineer with Young Radiator Co., of Racine, Wis., is now affiliated with the J. R. Meek Co., Tulsa.

Shaw has been associated with Young since 1942 and has had invaluable experience in the engineering field. He is a graduate of Purdue University, receiving a degree in mechanical engineering in 1931.

J. R. Meek Co. is the exclusive distributor of Young heat-transfer equipment in the Mid-Continent area.

Crystal Lake Site of New P&H Diesel Plant

Construction of a new factory and main office building in Crystal Lake, Ill., to house the diesel division of Harnischfeger Corp., has been announced by Henry Harnischfeger, vice president of the Milwaukee firm.

The factory, along with a smaller office structure, will occupy approximately 100,000 sq. ft. on an 80-acre site.

Production of diesel engines is slated to start October 1, when the plant will produce models ranging from one to six cylinders in size.

Karl Schoeppner has been appointed general manager for this new plant.

Transfers Announced By Wilson Manufacturing

E. W. SMITHSON

L. A. GOSDEN

Wilson Manufacturing Co., Wichita Falls, Tex., announces the transfer of two representatives in the sales and service department.

Ed W. Smithson has been transferred from Great Bend, Kans., to Carmi, Ill., and Louis A. Gosden, formerly in charge of sales and service at Carmi, has been transferred to Edmonton, Alta., Canada.

Monahan Appointed to New Post by American Optical

The appointment of John T. Monahan as assistant sales manager of the safety products division, American Optical Co., Southbridge, Mass., has been announced by C. H. Gallaway, sales manager of the division.

Monahan joined the concern as a development engineer in 1943 and worked on the development of respirators. In 1946 he was transferred to the safety-glass division, becoming manager of respirator and specialty sales in 1948.

He is a graduate of Holy Cross College, holding both a bachelor's and a master's degree in chemistry.

Continental Makes Changes

Continental Supply Co. has announced the following personnel changes: Frank E. Ellis has been appointed store manager at New Iberia, La., and Ike H. Metcalf has been appointed store manager at Laurel, Miss.

Oil Center Tool Names Witovec Vice President

Jim Witovec, who began as an apprentice machinist with Oil Center Tool Co. in 1930, was recently elected a vice president and director.

Witovec was the twelfth employe hired by Oil Center Tool, whose total employes today number 225.

After Witovec became a machinist, he later moved into setup and time-study work on machine operations. In 1945 he was named shop foreman and was promoted to shop production superintendent in 1948.

Reynolds New Executive Engineer for Catalytic

T. E. Webster, president, Catalytic Construction Co., Philadelphia, has announced that Thomas G. Reynolds has joined the refinery division of the firm as executive engineer. Reynolds has been closely associated with petroleum engineering since 1929. Prior to joining Catalytic, Reynolds was a process engineer with United Engineers & Constructors, of Philadelphia.

Reynolds is a 1928 graduate of University of Illinois with a B.S. degree in civil engineering. He was awarded a master's degree in chemical engineering at Columbia University in 1942.

Barnhill Added to Sales Force of West Texas Firm

L. (Barney) Barnhill has been named sales representative for Wichita Falls Foundry & Machine Works, Inc., manufacturers of catheads, air-tube clutches, Rotor seals, quick-release valves, V-belt pulleys, air-compression clutches, and water pumps. While Barnhill will maintain headquarters in Houston, he will cover all oil producing areas in the United States.

Barnhill formerly was with Mission Supply Co., serving the Mid-Continent area for 10 years, and was sales manager for Hinderliter Tool Co., Tulsa.

Calvert on Extended Trip To Foreign Fields

W. O. Calvert, export sales representative for Thornhill-Craver Co., Mission Manufacturing Co., and A-1 Bit & Tool Co., all of Houston, sailed from New York early in March for an extended tour of oil fields in England, Holland, West Germany, France, Italy, and the Middle East.

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UNDISPLAYED CLASSIFIED 12c a word one issue. 10% Discount three or more issues. $3.00 minimum charge. Blind Box in our care counts nine words. Payable in Advance.

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$12.00 a column inch one issue . . .
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EQUIPMENT FOR SALE

USED ROTARY AND CABLE TOOL DRILLING TOOLS, WIRE LINES, E. A. KELLY, BOX 861, OKLAHOMA CITY. PHONE 5-6407.

FOR SALE: 7500 foot drilling rig, Houston Portable, fully equipped and ready to go. Just completed 7500 foot hole. Standard or Emsco jack knife derrick optional. Two pumps, one 7¼x14 and 7¾x18. Will have to see this equipment to appreciate. Write or call for appointment. 525 Wichita National Bank Building, Wichita Falls, Tex. Telephone 9300.

FOR SALE: 3500' of used 4½ drill pipe with 5¾" O.D. full hole tool joints. Melton Supply Company, Seminole, Oklahoma.

1—3,000 GPM Fluor Atmospheric Tower, Model 23-A-15, California redwood; brass bolts, nuts and washers; copper nails; two distribution systems. Good condition. 1—Worthington pump, 1,500 gpm @ 30 ft. TDH, 1,800 rpm on base with 30 HP GE Motor. 1—Worthington pump, 800 gpm @ 110 ft. TDH, 1,750 rpm on base with 50 HP Motor. 1—Gould pump, 1,200 gpm @ 70 ft. TDH, 1,175 rpm on base with 35 HP Valley Electric Corp. Motor. 1—Ingersoll-Rand pump, 3,000 gpm @ 72 ft. TDH, 1,175 rpm with 100 HP Westinghouse Motor. All equipment available in May, 1951. Will sell all as a unit or separately. Located at 1100 East 21st Street, Wichita, Kansas. Derby Oil Company, P. O. Box 1030, Wichita, Kansas.

FOR SALE
NEW OIL WELL CASING & TUBING
Various sizes, steady supplies,
Prompt Delivery.
Wire or Write
Box D-953, The Oil and Gas Journal, Tulsa, Oklahoma

FOR SALE NOW—DELIVERY IN 30 DAYS
Used 7000' String
7" O.D.—26#-N-80-Casing
Mill-tested 5500# per square inch, six months old.
Box D-936
The Oil & Gas Journal, Tulsa, Oklahoma

Gaso Duplex 4½" x 6" Power Pumps with Chrysler C-36 Engines, skid mounted, immediate delivery. Also Byron Jackson, Carter Centrifugal Units. Westinghouse 20-25-50 KW Generating Units.
H. H. COFFIELD
Attn.: W. H. ORR
Phones: 132—Rockdale, Texas
AT-3427—Houston, Texas

Drilling Equipment
Steam Power Rigs for Deep Drilling
P. O. Box 8072—Houston, Texas

EQUIPMENT FOR SALE

AVAILABLE for sale and immediate shipment line pipe, seamless and lapweld casing, tanks. Call or write Edco Pipe & Supply Company, Box 565, Drumright, Oklahoma.

FOR SALE: In Kansas, 3—6" x 6" x 38' and 46' long rotary kelleys. $200.00 each. Cities Service Oil, Patridge, Bartlesville, Oklahoma.

FOR SALE: New International Tandem Axle Truck Model LF-192, Headache Rack, Tulsa Winch and Fifth Wheel Mounting; New Biltwell Tandem Axle Float and New Biltwell Tandem Axle Pole Trailer with fifth wheel connections and accessories. Actual Mileage 5426; Glen C. Shaw, 3312 N. Virginia, Phone 58-6190 or 3-3421, Okla. City, Okla.

BUCYRUS CABLE Tool Spudder 36-L 1948 Model, perfect condition, 54 foot mast, dual cathead, dual pneumatic tired wheels. All tools from 24", all accessories. An-Son Petroleum Corp., First National Bldg., Oklahoma City, Okla. Phone 7-4497.

EQUIPMENT FOR SALE

FOR CABLE TOOLS
DEGEN PIPE AND SUPPLY CO.
Box 107, Red Fork Station, Tulsa, Oklahoma

FOR SALE: 36-L Bucyrus-Erie Spudder, with L1-600 Cummins Diesel Engine, Unit skid mounted, 54' steel telescoping mast, with catheads, 5" to 7" tools, new lines, steel dog house, 3 K.W. Diesel light plant, steel structure and floors. All equipment practically new. Will furnish inventory on request. J. C. Shaffer, Inc., 3103 Apco Tower, Oklahoma City 2, Okla., Phone 6-9905.

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NAPALM
Attractively Priced
M. A. MIDDLEMAN
129 Pearl St., New York 5, N. Y.

PIPE—TUBING—CASING
Order Now—Immediate Delivery!

SEAMLESS TUBING—EXCELLENT FOR GAS, OIL, WATER FLOW LINES

Quantity	Size	Approx. wall	Description
75,000'	1½" O.D.	.140"	Recond. Seamless Tubing, P.E., 14' & Over.
15,000'	2" O.D.	.145"	2.7# Recond. Seamless Tubing, P.E., 14' & Over.
50,000'	2¼" O.D.	.140"	Recond. Seamless Tubing, P.E., 14' & Over.
20,000'	2½" O.D.	.145"	3.6# Recond. Seamless Tubing, 14' & Over.
60,000'	4" O.D.	.140/.160"	Recond. Seamless, P.E., 14' & Over.
5,000'	6⅝" O.D.	.....	18.97# Good Grade Used Lapweld, Cleaned, Beveled Ends, 20' Random Mill Lengths.

TUBING & CASING

20,000'	2⅜" O.D.	.....	4# Good Used Lapweld, Range 1 Tubing with New 11½ V-Threads and Collars.
10,000'	5½" O.D.	.....	15½# Good Used Lapweld T&C Range 1 Casing.
8,000'	7" O.D.	.....	20# Good Used Lapweld Range 1 T&C Casing, 11½ V-Threads.
5,000'	8⅝" O.D.	.....	25# Good Recond. Casing, T&C, 8 V-Threads Range 1.
600'	10¾" O.D.	.....	32.75# Good Used Lapweld T&C Casing, Range 1 New 8 Rd. Thds. & 8" Long Collars.

THIS MATERIAL IS AVAILABLE FOR IMMEDIATE SHIPMENT, SUBJECT TO PRIOR SALE.

OTHER SIZES OF LINE PIPE, SEAMLESS TUBING IN SUITABLE SUBSTITUTE SIZES FOR STANDARD PIPE (EXCELLENT FOR GAS, GATHERING AND FLOW LINES), CASING AND TUBING AVAILABLE FOR IMMEDIATE DELIVERY.

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A. J. STRUBEL, Broker

SIDney 1791 (Day Phone) HUDson 8152 (Night Phone) 4946 Murdoch, St. Louis, Mo.

EQUIPMENT FOR SALE

FOR SALE: 17½" Oilbath Gumbo Buster Rotary Table. 2—6" Gumbo Buster Swivels. Melton Supply Company, Seminole, Oklahoma.

FOR SALE: Galvanized Iron Pipe, diameters 1½" through 3" length 30" through 88" threaded for fill pipes or suction stubs for Gasoline Tanks. Armco Drainage & Metal Products, Inc., P. O. Box 1343, Atlanta 1, Georgia.

PIPE — PIPE — PIPE
4,000 ft. of New Plain end 6¼; 2,000 ft. of 8" Used Collars & Thread; #4 Jenson Jacks (New). A. R. Daniel, Garnett, Kansas.

FOR SALE: Three 1946 F. W. D. (4 Wheel Drive) Tractors. All in good condition. Low mileage. One having only 7,622 miles. Will sell cheap and will deliver. Write Heintzelman's, Inc., Box 3071, Orlando, Florida, or phone "Bob" at 3-3477 collect, Orlando, Florida.

10,000'-2¼" O.D. tubes in line in good condition—20c. 6,500'-4" O.D. tubes in line —50c. 1,000' 1½" standard black pipe. 3-60 B Ironcase Meters. Box 237, Chetopa, Kansas.

FOR SALE: Four ZC 503 & One ZC 208 used F & M Engines, good condition. Want good 2" or 2½" line pipe or tubing. Sell, buy or trade. Call, wire or write A. M. Moore, McCamey, Texas.

NEW 100 HP General Motors Diesel V-belted to 5x10 Wheatley Mud Pump, unit on skids. 1949 invoices total $6,800.00, now higher. Will take $6,500.00 FOB Coleman, Texas. Never pumped a gallon. O. B. Siler, Logansport, La.

FOR SALE: Model 32 Special Walker-Neer spudder in A 1 condition. If interested call or write I. Weiner, P. O. Box 1224, Big Spring, Texas, or phone 1438, Big Spring, Texas.

22-BUCYRUS; used little, clean, lengthened mast, trailer mount, tools, new cable, winch truck, $8800 drive away. Thomas M. Galey, Box 544, Owensboro, Ky., Phone 3-4959.

FOR SALE: Approx. 3000'—5½" OD, 20#, 8 RT, J-55, Range 2 Seamless casing, new collars and threads. 2300'—2" upset H-40, 8 RT, Range 2, seamless tubing, new. 3300'—4" OD 15.70# Pittsburgh seamless drill pipe, range 2 with Hughes Flash Weld, Full Hole Tool Joints. Pipe only made 33,000 ft. hole in Panhandle Texas since new. All types Boilers for sale. Phone 3957, Pampa, Texas.

EQUIPMENT FOR SALE

1—"OILWELL" Gas Booster Unit with size 6" x 11" TB Single Stage Compressor Complete with Bottom Discharge and Top Suction on the Cylinder, 57" PD 7-D Groove V-Belt Type Flywheel Pulley, Force Feed Cylinder Lubricator, Lubricated and Vented Metallic Packing, #8000 Gas Engine Cooler, one 14.2" PD 7-D Groove Pulley for Engine, Seven D-240 V-Belts, one 12 volt Storage Battery 140-170 A.H., Gauges for intake and discharge Gas Pressure, Thermometers for Water Cooling System, Necessary Piping and Fittings for Cooling Gas System and Gas supply to Engine, all assembled on Structural Steel Base with Waukesha Model 145 Gku 6-Cylinder Power Unit 5¼" x 6" Engine specially equipped for Gas Compressor Drive complete with: Air Cleaner—Oil Bath Type, Base Type Oil Pan, Natural Gas Carburetor, Water Pump, Bypass Thermostat, Filter-Lubricating Oil, Governor, Safety Magneto, Water Cooled Exhaust Manifold, Lubricator—Top Cylinder, Oil Pressure and Gas Pressure Gauge, Penn Safety Switches—High Water Temperature and Oil Pressure and Friction Throttle Control, Electric Starting—12 Volt and Twin Disc Clutch Power Take-Off. This outfit has been used a very short time and is in first class condition, complete with steel house, valves, fittings, gas cooler and pipes. Has been pumping ¾ million feet of gas per day against 400 lb. line pressure. $8000.00 F.O.B. Consumers Natural Gas Co., Box 669, Pikeville, Kentucky.

I OFFER 1,000,000 gallons lubricating oil ready to use, 80c per gal. Can pay cash 40c per gal. Balance long terms. John Stouppas, 175 E. Long St., Columbus, Ohio.

NEW Double Drum Well Servicing Unit Double Pole, 140 Hp. Waukesha, Fully Equipped. Box D-940, The Oil and Gas Journal, Tulsa, Oklahoma.

FOR SALE: 11,000 feet of 4" O.D. seamless tubing, random lengths, good, ready for line. Davis Construction Co., Parkville, Missouri. Phone 4051.

11,500 GAL. 200 lb. pres. U201 propane tank. 25,000 gal. 75 lb. pres. butane tank. L. M. Stanhope, Rosemont, Pa.

USED DRILLING AND PRODUCTION EQUIPMENT. GENERAL EQUIPMENT CO., 815 DANIEL BLDG. PHONE 2-6272, TULSA.

FOR SALE: Emsco JC 1250 sand reel, complete with substructure, 9500' of ⅝" wire line, in good condition, and complete Fawick air clutch. Assembly available for inspection by contacting Oil States Drilling Company, Box 1706, Big Spring, Texas, phone 2290-W. Price, $4250.00.

EQUIPMENT FOR SALE

FOR SALE: Two 12", 3000# WP, QRC Blowout Preventers. Used but like new, $9,000.00 for both. Lum Price, 417 E. 16th, Houston, Texas. Phone UNderwood 8945.

FOR SALE: 40 H.P. Bettis steamer, Tanks and steamer cab, Tools, Conns, Steam hose. On 1948 2-Ton Chevrolet truck. Price $3500.00. Frank Jones, McPherson, Kansas.

EQUIPMENT WANTED

WANTED: GAK Waukesha Motor, does not need to be in A-1 condition. Also, set of hydraulic jacks and rings for pulling casing. Crest Drilling Co., Petroleum Building, Wichita, Kansas.

GOOD Used Small Rotary Mounted, capable of drilling 1,500', Box 285, Iola, Kansas, or phone Office 355, Res. 278.

WANTED TO BUY—Good used drilling machine and equipment, capable of drilling to 3000 feet. Ralph M. Tolson, 816 Grandview, Pawhuska, Okla. Phone 834.

WANT Buy 9 Field Tanks 20,000 to 80,000 Bbl. Cap. Darien Corp., 60 E. 42nd St., N.Y., N.Y.

WANTED TO BUY
OIL WELL TYPE
ELECTRIC MOTORS

Ratings 15/30 Hp., 20/50 Hp. 25/65 Hp.
Send listing on any other Motors, Control, Cable, Wiring Supplies.

Industrial Electric & Supply Co., Inc.
P. O. Box 1398 Memphis, Tenn.
Phone 37-1681

HELP WANTED

WANTED: College graduate, three or more years' experience in petroleum refining, for technical sales in established line of chemical products used by petroleum industry. Locations—Gulf Coast Area, West Coast. Letter should include details of education and experience, family and military status, salary expected and recent photo. State geographical preference. Box D-939, The Oil and Gas Journal, Tulsa, Oklahoma.

WANTED: Associate or full professor of Petroleum Engineering in a leading institution. Must have successful professional and research background. Work to begin September fifteenth. Box D-897, The Oil and Gas Journal, Tulsa, Oklahoma.

INSTRUMENT MAN in independent refinery in Chicago area. Minimum 5 years experience and practical refinery instrumentation on cracking and distillation processes. Box D-947, The Oil and Gas Journal, Tulsa, Oklahoma.

FOREIGN and Domestic Oil Employment Directory covering the oil industry, showing where to apply for jobs. Price $5.00. Oil Industry Mailing List, Box 2603, Tulsa, Okla.

DRILLING ENGINEER for Venezuelan assignment. College degree in Petroleum or Mechanical Engineering plus drilling and well completion experience. Give full details in reply to P. O. Box 2819, Dallas, Texas.

EXPERIENCED Petroleum Engineer, by Independent Geological Firm, familiar with Secondary Recovery and experienced in making appraisal reports. In applying please give detailed experience and salary expected. Interest participation if qualified. Box D-942, The Oil and Gas Journal, Tulsa, Oklahoma.

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OPERATIONS SUPERVISORS
PERFORATOR OPERATORS
Only Experienced Men Need Apply
WRITE ONLY
WELEX JET SERVICES, INC.
3900 Hemphill Street, Fort Worth 9, Tex.

COMPLETE DRILLING RIGS FOR SALE

1. **NATIONAL 50** Ideco 136' mast, National C-350 and G-D FXQ pumps. Two 12 cylinder LeRois on draw works and FXQ pump. Two Waukesha LROs on C-350.
2. **EMSCO GA-500** Ideco 136' mast, National C-350 and G-D FXQ pumps. Two GM Twin diesels on draw works and FXQ pump. One GM Quad diesel on C-350 pump.
3. **EMSCO J-750** Ideco 136' mast, G-D FXL and Emsco P-16 pumps. Three GM Twin diesels on draw works, power takeoffs to both pumps, two GM Quad diesels, one on each pump.
4. **NATIONAL 125** One Oilwell 220P pump, one Oilwell 20P pump, one W-S 7P pump. Four Waukesha LRO engines with National fluid couplings on draw works with takeoff to 220P pump, two Waukesha LROs with National fluid couplings on 20P pump, one Waukesha EKH on 7P pump.
5. **K-W RIG** Emsco UB-54 draw works with National reverse gear, Ideco 136' mast, National C-350 and Emsco CA-16 pumps, two 12 cylinder LeRoi gas engines on draw works, two Waukesha LROs on C-350 pump, one Superior 6G510 on Emsco pump.

EACH OF THESE RIGS IS COMPLETE AND READY TO DRILL. EACH IS FULLY UNITIZED FOR SPEEDY MOVING AND RIGGING UP. REASONABLY PRICED. FOR FULL PARTICULARS AND COMPLETE INVENTORIES CONTACT

Rocky Mountain Drilling Company
612 South Flower Street Los Angeles 17, California
Phone Michigan 6215

HELP WANTED

GEOPHYSICIST: Fully qualified and experienced for position of Chief Geophysicist with well-known contracting company. Application must state complete qualifications, references and salary expected. Box D-918, The Oil and Gas Journal, Tulsa, Oklahoma.

SEISMOGRAPH PARTY CHIEF and Computer wanted by new aggressive company. Box D-920, The Oil and Gas Journal, Tulsa, Oklahoma.

ENGINEERS, Executives, Technical Men. Salaried positions—$3600 to $30,000. This confidential service for outstanding men who desire a change of connection. Will develop and conduct preliminary negotiations without risk to present position. Send name and address for details. Tomsett Associates, 1204 Berger Bldg., Pittsburgh 19, Pa.

CHIEF Geophysicist for Venezuelan assignment. Must be proficient in handling seismic, gravity, torsion balance, magnetic and other data. Should have college degree in geology and/or geophysics plus active experience in geophysics. Give full details in reply to P. O. Box 2819, Dallas, Texas.

WANTED: LAND MAN
Thoroughly experienced in Oklahoma Oil Fields. Box D-935, The Oil and Gas Journal, Tulsa, Oklahoma.

WANTED: Expert tool pusher for North Carolina wildcat. Minimum one-year work. Bonus. Box D-951, The Oil and Gas Journal, Tulsa, Oklahoma.

GEOPHYSICAL SURVEYOR: Minimum two years' experience on transit; do not apply otherwise. Box D-921, The Oil and Gas Journal, Tulsa, Oklahoma.

MATERIAL MAN for Venezuelan assignment. Must have experience and thorough knowledge of production and drilling equipment. Give full details in reply to P. O. Box 2819, Dallas, Texas.

SALES ENGINEER with recent mechanical engineering degree to join organization handling equipment for refineries, gasoline and chemical plants in Houston. Experience not essential. Box D-948, The Oil and Gas Journal, Tulsa, Oklahoma.

ELECTRICAL Engineer with crude oil pipe line experience. Familiar with design of electric pump stations, auxiliary electric machinery and equipment, remote control circuits, power sub-station and distribution circuits for installations up to 5,000 horsepower. Familiarity with communication circuits and electronic equipment also required. Include full professional and personal details first letter. Box D-933, The Oil and Gas Journal, Tulsa, Oklahoma.

ENGINEERS . . .

For Career Employment in FOREIGN SERVICE

A long established Oil Company operating overseas has positions for Mechanical and Process Engineers in REFINERY Engineering, Maintenance and Technical Service work.

These positions call for graduate Engineers—Recent graduates or up to ten years experience in the fields of Civil, Mechanical, Electrical and Chemical Engineering. Up to 35 years of age. Salaries in line with experience; at least 25% above comparable domestic positions plus other benefits including early retirement.

Replies will be kept confidential. Write giving full details to

Box D-954, The Oil and Gas Journal, Tulsa, Oklahoma

SITUATIONS WANTED

ATTENTION: Well established oil well drilling contractor desires to manage and supervise: Individuals', groups', small or medium-sized oil companies' drilling, production and operating problems in Central and Western Texas, and New Mexico. Personal interview by appointment is desired. Makin Drilling Company, Box No. 131, Ph. No. 131, Hobbs, New Mexico.

DRILLING Contractor operating in West Texas and New Mexico desires to contact small or medium-sized independent oil company who needs an operating manager. Personal interview desired. Twenty years experience in all phases of the oil industry. Address replies to Box D-644, The Oil and Gas Journal, Tulsa, Oklahoma.

PETROLEUM and Gas Chemist, B.S., 14 years experience, married, 38 years old, wants position Dallas, Texas, only. Member A.C.S. and A.S.T.M. Excellent references. Box D-944, The Oil and Gas Journal, Tulsa, Okla.

PRODUCTION ENGINEER: Age 29, Graduate Petroleum Engineer, University of Texas. Four years varied experience—production, drilling and work-over in Mid-Continent and Gulf Coast Areas. Desires connection with active independent or drilling contractor. Applicant has substantial geological and reservoir engineering background. Box D-943, The Oil and Gas Journal, Tulsa, Oklahoma.

GEOPHYSICIST 15 years experience available July seeks permanent location supervising interpreting reviewing seismic gravity magnetics in Caribbean Area, Brazil, Mexico, Peru. Box D-937, The Oil and Gas Journal, Tulsa, Oklahoma.

GEOLOGIST-LANDMAN. Wide and varied experience, now with major company and wishes to remain in Rocky Mountain Area. Capable of taking complete charge of operations. Desires salary-interest or will consider retainer basis. Box D-929, The Oil and Gas Journal.

EXPERIENCED Geologist, with major company experience in Permian Basin. Am interested in contacting an active independent in this area. Available immediately. Box 1826, Midland, Texas.

GEOLOGIST: Age 35, married, 12 years major and independent company experience in Texas and Louisiana Gulf Coast, Southwest Texas, West Texas-New Mexico. Desire connection with Active independent. Excellent references. Box D-952, The Oil and Gas Journal, Tulsa, Oklahoma.

PETROLEUM ENGINEER: Graduate engineer with fourteen years' excellent experience desires to change employment. Interested in production engineering in Mid-Continent or Gulf Coast states. Box D-927, The Oil and Gas Journal, Tulsa, Okla.

ENGINEER, 27, slightly disabled veteran, wants job where intelligence, initiative, and industry important. 3½ years major company experience production and reservoir engineering, some drilling. Currently division reservoir engineer. Desire personal interview. Box D-946, The Oil and Gas Journal, Tulsa, Oklahoma.

WANTED

WANTED: Drilling contractor with equipment for drilling immediately minimum-guaranteed ten wells North Carolina ranging from depths 2000 ft. to 5000. Full equipment necessary but pipe supplied by us. Box D-950, The Oil and Gas Journal, Tulsa, Oklahoma.

ROYALTIES

SPOT CASH PAID FOR PRODUCING ROYALTY. SMALL TO LARGEST BLOCKS IN SETTLED OR OLD PRODUCTION ONLY. Oil Specialists since 1934. GERBER & CO., 120 WALL STREET, NEW YORK.

WE will buy your producing override royalties and oil payments, no matter how small. Emray Oil Co., B. R. Irwin, President, 1045 Electric Bldg., Houston, Texas. Phone—Charter 3479.

DEEDED ROYALTIES
San Juan Basin & Permian Basin. Write Harry S. Wright, Wright Bldg., Farmington, New Mexico.

MONTANA ROYALTIES
Millions of acres now leased by world's major companies, with huge drilling play in prospect. For booklet describing Montana geology and oil development, write Landowners Royalty Company, Box 1225, Great Falls, Montana.

PRIVATE PARTY wants to invest up to $150,000.00 in producing royalties or settled production. Small or large deals considered. Box D-912, The Oil and Gas Journal, Tulsa, Oklahoma.

WE will buy producing or non-producing oil royalties. Sstandard Security Company, 115 Broadway, New York 6.

LEASE AND DRILLING BLOCKS

ARIZONA five-year leases and drilling blocks, good geology, 620 Luhrs Building, Phoenix, Arizona.

WATER flood prospect in Allen County, Kansas, now available for salvage plus limited override to a responsible operator only, preferably one with water flood experience. Approximately 100 proven acres of Bartlesville sand—700′ deep—32 gravity oil. One core (good) taken by owners—coring option if desired. Box D-949, The Oil and Gas Journal, Tulsa, Oklahoma.

DEVELOPMENT Contract, Several Drilling Blocks having attractive geology. Also Natural Gas Distribution and Development project having 500 possible taps. Old oil production for sale. C. P. Taneyhill, Industrial Engineer, P.O. Box 304, Bowling Green, Kentucky.

SACRIFICE for immediate cash, 7½ per cent, 4 wells, $30,500, marvelous potential; Alberta. Write today. Box D-945, The Oil and Gas Journal, Tulsa, Oklahoma.

ACTIVE N.M. OIL AREAS
We recommend to buyers leases & royalty located in Major Oil Co.; seismograph blocks, where deep wells are projected in S. Roosevelt, N. Lea & Chaves County, New Mexico. Details these potential oilfields on request.

W. J. PETERMAN, Geologist
Portales, New Mexico

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LEASE AND DRILLING BLOCKS

FOR SALE

PROPERTY IN PARADIS OIL FIELD

St. Charles Parish, Louisiana

Hibernia Bank & Trust Company, in Liquidation is inviting offers for the purchase of certain of its interests in the Paradis Oil Field involving over

9000 ACRES

For particulars write:

Hibernia Bank & Trust Company, in Liquidation

Jasper S. Brock, State Bank Commissioner
Thos. B. Kennair, Special Agent
J. Edward McGuire, Liquidator
405 Baronne Bldg., New Orleans, La.

FOR SALE: Oil and Gas Leases adjoining producing leases, also wildcat leases. Drilling propositions and small producing properties; all in shallow territory. W. P. Harley. Bowling Green, Ky.

ONE-FOURTH interest 80 acres with new well. Produced over 22,000 bbl., 90 days. Price $12,500 for 1/16—no proration. Box D-926, The Oil and Gas Journal, Tulsa, Oklahoma.

COLORADO Oil-Gas Leases: Lincoln County, 10,000 acres; Kiowa County, 15,000 acres; Crowley County, 15,000 acres. All or part for sale at $1.00/acre (Renewal-$0.50/acre). For Sale: Ranch land with oil possibilities. E. H. Grantham, Realtor, Ordway, Colorado.

IDEAL drilling block 1171 A in Shelby Co. Texas surrounded by Major Co. Holdings both shallow and deep prospects consider drilling deal or cash. C. A. Parker, Center Texas.

WANT TO LEASE an 80 for gas and oil. West ½ of the SW ¼ of Sec. 22-7-2 in Pottowatomie Co. Edward F. Luettig, R. A. #2. Freeport, Illinois.

LARGE INDEPENDENT wants properties to repressure. Give full details and price for quick action. Box D-925, The Oil and Gas Journal, Tulsa, Oklahoma.

28,000-ACRE block of Oil and Gas leases. Interested in turning for small overriding agreement or cash. Lloyd J. Twibell, Orchard, Nebraska.

REAL ESTATE

60 A. ESTATE, Orange County, Calif. Part Citrus. Excellent location, 22 miles L. A. City Hall. Leased to Major Oil Co. 50% mineral rights. $1750 per acre. Terms. FRontier 28138, R. D. Freed, 438 30th St., Hermosa Beach, Calif.

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PATENT ATTORNEYS

PATENT Practice before U. S. Patent Office. Validity and Infringement Investigations and Opinions. Booklet and form "Evidence of Conception" forwarded upon request. Lancaster, Allwine & Rommell, Registered Patent Attorneys, Suite 418, 815-15th Street, N.W., Washington 5, D. C.

Geologist Deferments Urged

WASHINGTON.—Unwise manpower policies causing the loss of trained geologists and geophysicists to the Armed Services will imperil our ability to prepare and maintain an adequate national defense, the American Geological Institute warned last week.

A resolution adopted by the board of directors of the institute, composed of 12 national geological and geophysical societies which represent the approximately 17,000 individuals in those professions, called upon mobilization planners and educational agencies to maintain an increasing number of geologists and geophysicists at work to locate the expanding amounts of oil and strategic mineral supplies needed for civilian and military purposes.

"The United States can neither sustain an expanding defense economy nor meet a war emergency without accelerating the rate of discovery of essential minerals such as oil, gas, metals, and strategic materials," it was pointed out.

Rube Goldberg Views the News for His Latest Invention

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RUBE GOLDBERG
HOW TO CURE BALDNESS
ELLIOTT ROOSEVELT (A) CARRIES NEWEST BRIDE ACROSS THRESHOLD, UNCOVERING EASTER BONNET (B) DECORATED WITH FRESH FRUIT--FAMISHED BRITISH LION (C) DIVES FOR FRUIT, CAUSING WEIGHTS (D) TO TIP BASEBALL WORLD (E) AND DUMP HAPPY CHANDLER (F)--HE SHEDS UNHAPPY TEARS (G) CAUSING HIGH TIDE AND BRINGING IN FREIGHTER (H) WITH LOAD OF LATEST FRENCH FUR COATS (I) FOR EVA PERON (J)--SHE QUICKLY THROWS AWAY OLD CHINCHILLA MUFF (K) WHICH LANDS ON BALD GENTLEMAN (L) GIVING HIM FULL HEAD OF HAIR.
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gas field, United Fuel Gas Co. has completed 28 Kentland Coal & Coke Co. for 880,000 cu. ft. of gas daily from Devonian black shale at a total depth of 4,584 ft. The company completed 6612 Dallas Kazee for 158,000 cu. ft. gas daily from Devonian black shale at total depth 3,398 ft.

EASTERN KENTUCKY WILDCAT FAILURE

Rowan County: J. Frank Hinkle 1 D. C. Caudill, 7-T-71, dry, TD 525 ft., in Corniferous lime.

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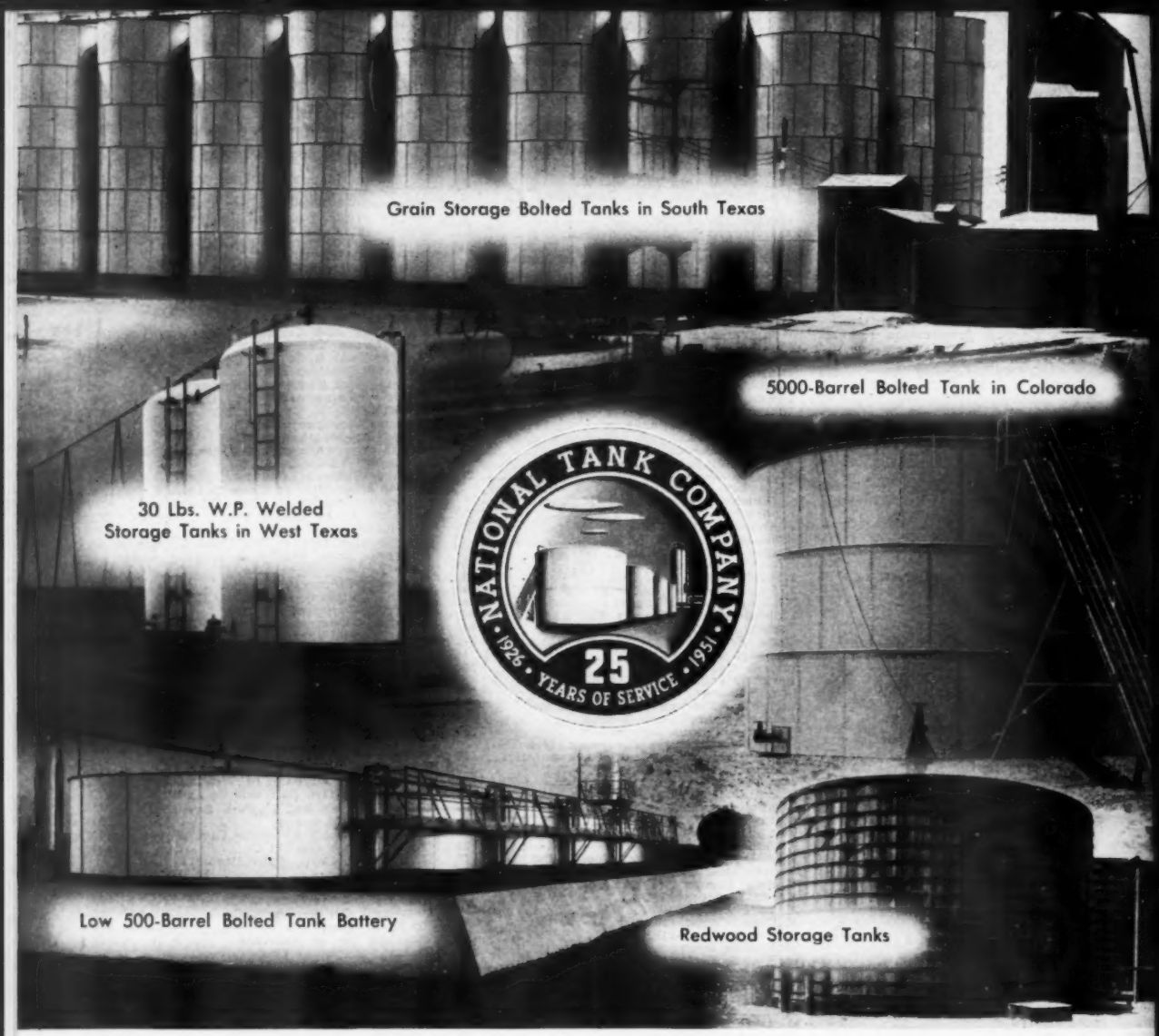
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Redwood Storage Tanks

National Serves The Oil Industry EVERYWHERE!

National Tank Company has constantly expanded its facilities during the past 25 years to keep pace with the demands of an ever-growing, world-wide market for National's products. The development and production of many National "Firsts" are responsible for this growth.

Our highly-skilled research and engineering staff is constantly making new discoveries. They are designing and producing newer, bigger, faster equipment to bring to the petroleum, chemical and manufacturing industries increased production with more economy and greater safety.

National recently increased its plant capacity to seven acres under one roof—added many new plant facilities and equipment to assure that "It's a National" means the finest!

It's a National

NATIONAL TANK COMPANY

TULSA, OKLAHOMA

XUM

XUM

XUM

LAY-SET PREFORMED

the Premium

Only the finest is branded **"*Premium.*"** Only the best gets the blue ribbon for unequalled quality. Only one is recognized as the grand champion winner which sets the standards of excellence . . . whether it's beef on the hoof, a beauty contest winner, or a brand of wire rope.

HAZARD since 1846 has produced premium wire rope . . . made better so that it will last longer, handle safer, and cost less to use. **LAY-SET** Preformed has been used —with excellent results—in every conceivable type of wire rope service. Its satisfactory performance has proved **LAY-SET**'s right to be called—"*the Premium Brand.*"

There is a **HAZARD** distributor near you to serve you with this premium brand of wire rope.

ACCO *In Business for Your Safety*

ALSO MAKERS OF THE COMPLETE LINE OF Registered WIRE ROPE SLINGS

AMERICAN CHAIN & CABLE

HAZARD WIRE ROPE DIVISION

TRADE MARK

Wilkes-Barre, Pa. · Chicago · Denver · Houston · Los Angeles · New York · Odessa, Tex. · Philadelphia · Pittsburgh · San Francisco · Bridgeport, Conn.

What Hughes field service means

Good service, to us, means *anticipation* of your needs *at the rig*.

Hughes Tool field men keep in constant personal touch with every rig in their territory, consulting with pushers, drillers and other field personnel on rock-bit performance and requirements.

The Hughes service organization consistently covers all of the active oil fields in the U. S. and Canada wherever you find rotary drilling. Hughes men visit more rigs more times. This vigilant Hughes service anticipates rock-bit requirements to insure having the *right bit* at the *right time*.

Hughes Tri-Cone Rock Bits